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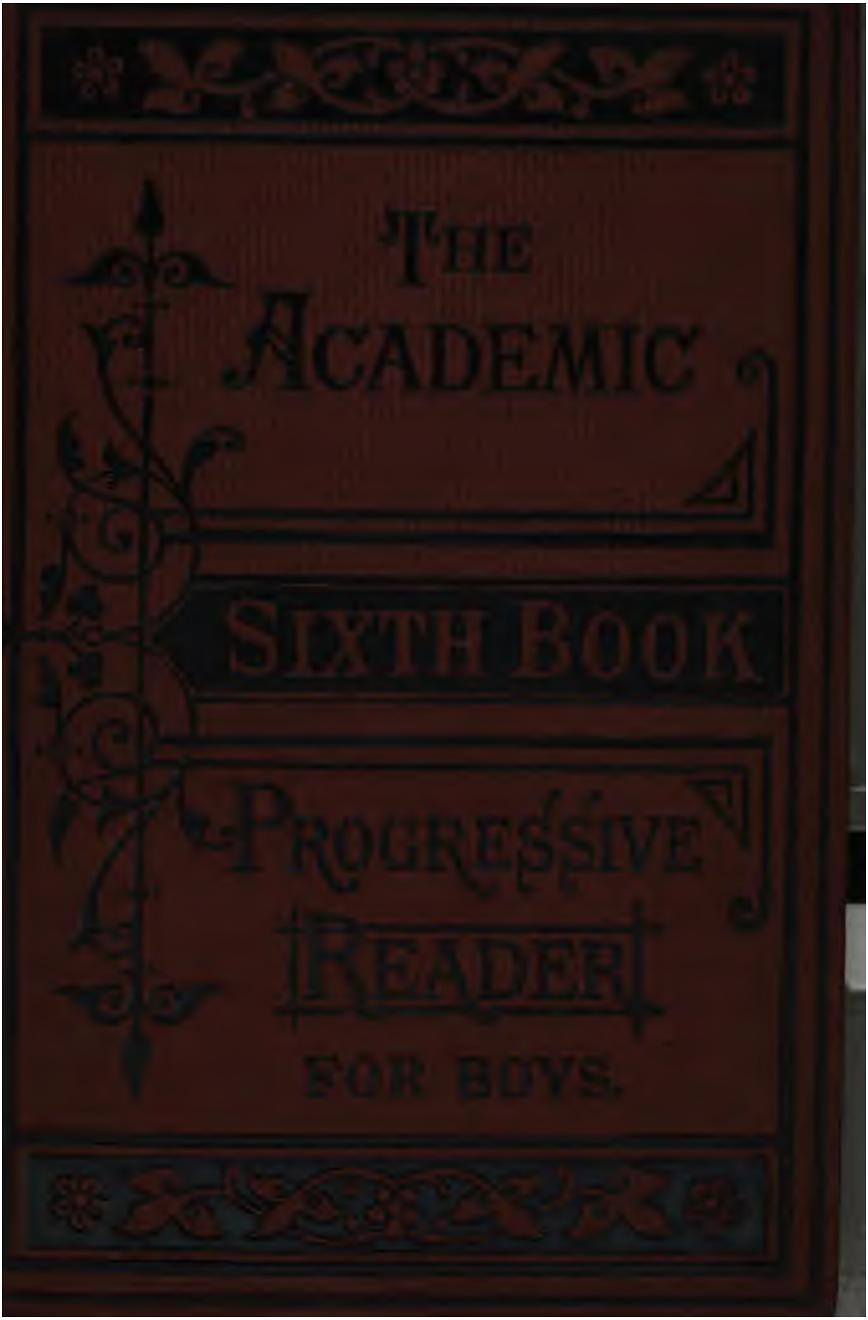

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James Ridgway.

Training College,
Culham, Oxon.

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ROBERT AND WILLIAM CHAMBERS.

Part I.

This worthy pair of brothers were born in Peebles, of a family who had lived there from time immemorial. Latterly the heads of the family had been woollen manufacturers, substantial and respectable people, although living in a very plain way. The father of the brothers carried on the business of a cotton-spinner rather extensively, "having sometimes as many as 100 looms in his employment." "Peebles, in the early years of this century," says Robert Chambers, "was eminently a quiet place." "As quiet as the grave or Peebles" is a phrase used by Cockburn. It had an old town and a new town, and the inhabitants were a simple race, living in "buts and bens," and sleeping in "box-beds" so close as almost to stifle their inmates.

It was in a small burgh with such original inhabitants, that the father of the brothers began housekeeping in 1799, having just married Miss Jean Gibson, a woman of whom it is the best praise to say "that both in appearance and manners she was by nature a lady, and that circumstances made her a heroine. Though delicate in frame and with generally poor health, such," says her son, "was her tact and dexterity as well as her determined resolution, that she bore and overcame trials under which other women would have sunk." As for their father, he can best be described as always waiting for something to "turn up," and ever finding it "turn up," through his own weakness, the wrong way. Like many other characters who bring ruin on themselves and others, he was not undeserving of regard. He possessed numerous estimable qualities, but in association with these a pliancy of disposition which renders a man his own worst enemy. He was "conscientious, but inconsiderate, easily misled, lacking fortitude, and constantly exposed to imposition." He was an untiring performer on the German flute, which divided his affections with a telescope. His convivial turn led him into such society as the burgh afforded, and it is hardly to be wondered at, that, between this and his flute and his telescope, his cotton business began to go to the dogs, and, once going, rapidly came to nothing. Besides these shortcomings of the man, there were other agencies at work sufficient to cause ruin; the introduction of the power-loom revolutionized the cotton trade; down and down sank handloom weaving, and with it a lucrative commission business which the elder Chambers carried on. Ever sanguine, he alienated some house property, and set up as a draper, when the finishing blow to his success in Peebles was dealt by the departure of a large number of French prisoners, to whom he had given unjustifiable credit. On the eve of their return to their native country, those light-hearted sons of France swore that nothing could give them more pleasure than to pay their debts when they got home. We need scarcely say that they went, but not one of them ever paid a farthing. Then came a crisis in the affairs of Mr. Chambers; his estate was wound up, to the small benefit of either his creditors or himself, the lawyers getting, as usual, the lion's share. With drooping heads the family left Peebles, and took refuge in Edinburgh, "my mother," says her eldest son, "with but a few shillings in her pocket; there was not a half-penny in mine."

It was while their father's business in Peebles was flourishing, that William and Robert Chambers were born; the first in 1800, the other in 1802.

William, the elder, was sent to different schools, first to a dame's, next to a man named Gray, where the fee was 2s. 6d. per quarter for reading and writing, and 6d. additional for arithmetic. After that he went to the Grammar School, under a Mr. Sloan, where the fee for learning Latin was 5s. a quarter, and where his progress was very indifferent. At both these schools Robert had followed his brother's steps, with this difference, that he had better abilities, or at any rate more application, and soon became a favourite pupil. We need hardly say, that those were the days when boys were flogged unmercifully, in return for which they kicked each other, harried birds' nests, and pelted cats. "I've brought you our Jock, mind ye lick him weel," were the words of a Spartan Peebles mother, dragging forward a young savage to be entered. While the boys were pursuing their education in this way it was greatly helped, so far as Robert was concerned, by a copy of the *Encyclopædia Britannica,* which an enterprising bookseller at Peebles had bought, and, finding no one cared to read it, had parted with it to Mr. Chambers, the father, who stowed it away in an attic. To that book, more than anything else, Robert attributes his taste for reading, and he relates the thankfulness which he felt when he discovered such a treasure stowed away in a lumber room. So promising was Robert considered at the Grammar School, that he was left behind at Peebles to pursue his studies when the family went to Edinburgh in 1813.

* * *

With their arrival in the Scotch capital, the Dark Ages of the house of Chambers began, as the brothers afterwards jestingly called them. They lived in a poor way in a floor opening on a common stair in West

Nicolson Street, and their neighbours as well as themselves were "hard up," as William says. The elder Chambers tried with small success to continue his commission business, and privations ensued, for which his old German flute, preserved as a precious relic, was his chief consolation. William was now in his 14th year, and something must be done with him. At first his taste inclined to being an apprentice in a bookseller's shop, but, not succeeding at once in that, he was very nearly serving a grocer in the same capacity; but most fortunately, on presenting himself at the shop, he was pronounced by the grocer, after a competitive examination confined to his muscular powers, to be physically unfit for the office. On his way back, rather down-hearted, the boy saw in the shop of Mr. John Sutherland, Calton Street, the welcome announcement "An Apprentice Wanted." He presented himself, and was at once accepted. As for his duties, he was only to light the fire, take off and put on the shutters, clean and trim the oil lamps, sweep and dust the shop, and go all the errands. "When I had nothing to do," Mr. Sutherland said, "I was to stand behind the counter and help in anything that was wanted; and, talking of that, it would be quite contrary to rule for me ever to sit down or put off time in reading." The boy consoled himself on being told that "Constable and all the great booksellers had begun in that way;" and so, with the consent of his brave mother, who conducted the negotiation, William Chambers began life as John Sutherland's apprentice for five years, at 4s. a week. This was on the 8th of May, 1814.

About a year and a half after this event something turned up for the father. He was appointed commercial manager of the Joppa Pans, a salt manufactory between Portobello and Musselburgh, and thither they all went except William, for Robert had now left Peebles, and was at an Academy in Edinburgh, the arrangement being, so far as he was concerned, that he should walk to and from town daily. William was now left to his own resources, and at a little over fifteen had to make

4s. a week serve for everything. He says he never had the smallest despondency on the subject. He was much assisted in his plans by an honest widow, a Peebles woman, who consented to let him have a bed, cook for him, and allow him to sit at her fireside for 1s. 6d. a week; the fire, as he remarks, being "not much to speak of." With regard to his food, he tells us, "as a final achievement in the art of cheap living, I was able to make an outlay of 1s. 9d. suffice for the week." He thus had 9d. left out of his wages for other demands, chiefly for shoes, which were a heavy item. Thus the lad lived, and he can now write with honest pride, "On no occasion did I look to my parents for the slightest pecuniary subsidy."

As for his work, John Sutherland was a stern disciplinarian, and seemed to have no regard to the number of miles that his apprentices walked in the day. Besides his regular business, he kept a circulating library and was agent for a State Lottery. The duties of young William, therefore, besides the regular errands of a shop, combined that of carrying large parcels of books, and delivering the letters containing lottery tickets, so that in this latter respect he was little better than a postman. Still he had to bear it, and he consoled himself by an inscription which he passed daily over the doorway of an old house in the West Bow—

"He that tholes overcomes."

One would have thought the boy had work enough, but in the bitter winter of 1815-16 he was so fortunate as to hear of a literary baker, who, passionately fond of reading, had no leisure to read himself, but would give him a penny roll from his oven every baking morning if he would go early, say at five a.m., and read aloud to him and his two sons, while they were preparing their batch of bread. He accepted the offer, and long read for two hours and a half every morning to the baker, who allowed him to choose his subject, only stipulating that it should be something comic and laughable.

On Saturday nights, between nine and ten o'clock, for several years, the hard-worked apprentice walked down to Portobello to see his family, and spend Sunday with them. On that holy day the noxious salt pans ceased to smoke and poison the face of the country, and, after church, the brothers had long walks over the neighbourhood. On Monday morning he was up and away to take down the shutters, cheered by admonitory hints from his mother to avoid low company and "aye to haud forrit," while his father was full of wise maxims to his son on the great good of self-denial, and the absolute necessity of independence in life. It so happened that the views of Mr. Chambers did not comport with his duties as manager of the salt-works. The business was really a contraband one, arising out of the profit made by smuggling salt into England. This did not suit the manager's views of propriety, and for some reason or other a quarrel arose between him and his employers, which was heightened when Mr. Chambers was waylaid and robbed of some money which he had collected in Edinburgh, knocked down, and bruised about the head. He was found lying helpless on the road, and, in the words of his son, "the painful circumstances connected with this untoward affair led to his being discharged." With her husband in this helpless state, everything fell on his wife. All the son could do was to press into his mother's hand half a sovereign, which some lucky holder of a lottery-ticket had given him, and to hasten back to work. Mrs. Chambers set up a small business on the road to Musselburgh, where she, by great exertions, maintained herself, her husband, and her young children, while her sons, now at the very darkest period of those dark ages, fought the battle of life for themselves in Edinburgh.

In the meantime, Robert's education had come to an end, leaving him a good Latin and general scholar, with a turn for those antiquarian and topographical pursuits which stood him in such good stead in after life. But now the time had come when he, too, must do something for himself. For a while he tried tuition, and walked ten miles a day to and from his work with poor requital, but at the end of six months this came to an end, and after a few weeks he was "discharged" from a similar situation as "too stupid." At this moment a brilliant idea came over his brother William. Nothing less than that Robert should set up as a bookseller, using for his stock-in-trade a number of old books which the family had dragged about with them from place to place. So, with their father's consent, all the old books, except one old family Bible, were handed over to Robert, and with them, at the age of sixteen, in the year 1818, he set up a bookstall in Leith Walk. He hired a poor shop, at a yearly rent of £6, with space for a stall in front, and there William went to live with him and keep him company. It was in May, 1819, that William's apprenticeship came to an end, and then with five shillings in his pocket, his last week's wages, he was, at nineteen years of age, left to his devices. The success which had attended Robert's venture was such as to encourage William to try the same line, but then Robert had carried off all the family books, and there were none left for William as his stock-in-trade. But here fortune favoured him by bringing an active London publisher, who dealt in remainders, to Edinburgh, where he held a sale, at which William was useful to him. Taking a fancy to the young man, the publisher allowed him to choose on credit a sufficient stock to set up a stall, and from that moment the Dark Ages began to grow lighter with both the brothers, and their career afterwards was one of constant success. Of course, as Rome was not built in a day, they found it hard work; and they even made their own stalls, William being especially handy in this way. On the first day William cleared a profit of 9s. 3d., which put him in high spirits. As the contents of his stall disappeared, day by day, he bought fresh parcels of books at auctions, and both the brothers were soon regularly recognized as belonging to the trade, which they eked out in various ways by selling flutes and other things saleable in Leith Walk, then, as now, the great thoroughfare between Edinburgh and her seaport. "Within six months," says

William, "the most critical part of my struggle was over." At that time the united daily expenses in housekeeping of the brothers did not exceed a shilling. For years after beginning business the cost of William's own living was limited to sixpence a day, and all that was over of his profits he laid out in adding to his stock. He saved in every way, buying his books in sheets and putting them into boards himself, saving on an average 3d. or 4d. a volume. His leisure time he spent in writing pieces of poetry in a fine hand, and selling them for albums; then he bought an old printing-press and types, in order to unite printing with his other business. The outlay was only £3, and with this miserable fount he actually printed a pocket edition of Burns, and after months of toil, which he considered cost nothing as he had time on his hands, in the interval of minding his stall, he sold off the whole edition, and cleared £9, by the transaction. Next he added a circulating library to his stall, and painted a sign, which he set up over his stall announcing that he was "bookseller and printer." So he went on, now printing "rules for friendly and burial societies," now striking off pawnbroker's tickets, now executing an order for 10,000 shop-bills, and at last buying a new fount of type, and starting a periodical called the *Kaleidoscope*, from the optical toy just invented by David Brewster. It was to appear once a fortnight; the price was to be 3d.; Robert was to be editor and principal writer, and William to be printer and publisher, contributing occasional articles. It was on the 1st of October, 1821, that the *Kaleidoscope* first appeared, and, though it did not last, it paid its expenses, and was a trial of the brothers' wings, and encouraged them to higher flights. The last number appeared on the 12th of January, 1822. From about this time the brothers began to have larger views. Those three or four years of hard work had fulfilled every reasonable expectation. Robert's small stock had increased to be worth about £200, and William's position was as prosperous. Leith Walk had served its turn. The brothers were made for better things than keepers of bookstalls, and printers of shop-bills and pawnbrokers' tickets, although they migrated from the Walk and their stalls with a feeling akin to regret. Robert removed to India Place, Edinburgh, in 1822, and William to Broughton Street in 1823; both places being stepping-stones to something better.

PART II.

If the period between 1818 and 1822 were the Dark Ages of the brothers, the ten years between 1822 and 1832 may be called their Mediæval Period. In them Robert shewed literary power of a higher kind than was to be seen in the *Kaleidoscope*, and began by publishing his *Illustrations of the Author of Waverley*, a book made up of short sketches of persons in the south of Scotland, popularly believed to have been the originals of characters in the earlier novels of Sir Walter Scott. It would have been strange if, in these guesses, the writer had not sometimes gone a little wide of the mark, but on the whole these speculations were wonderfully correct. The book appeared in 1822, William, of course, being the printer, and was well received at the time, and republished in 1824. After being settled in India Place, Robert designed and, in 1824, brought out, (William being again printer and publisher,) his *Traditions of Edinburgh*, in which he collected all the old stories about the Scottish metropolis which he could either gather from books or from the memories of old and remarkable inhabitants. It appeared in parts, and after the first, materials almost unbounded came to the young author, chiefly, as he says, "from aged professional and mercantile gentlemen," and among the rest, from the well-known Charles Kirkpatrick Sharpe, now best remembered, perhaps, by the caricature portrait which he drew and published of Queen Elizabeth dancing before the Scotch Ambassadors. As soon as the first part came out, it attracted the attention of Sir Walter Scott, who told Mr. Constable he wondered "whence the boy got all that information." He came from Tweedside, too, and that was a sure way into Sir Walter's heart. It was not, however, till the first volume was completed, that Sir Walter overwhelmed the bashful author by calling on him in company with Mr. Lockhart. A very few days after this visit Robert Chambers received from the great novelist, along with a very kind letter, sixteen folio pages of manuscript, containing all the reminiscences, which he could summon up at the time, of old persons and things in Edinburgh. This was the beginning of a constant intercourse between the two, which only came to an end with Sir Walter's death; and when, later on, Robert Chambers was preparing his *Popular Rhymes of Scotland* Sir Walter lent him "whole sheets of his recollections, with appropriate explanations." Before the *Traditions* were finished, Robert Chambers was well and favourably known as a rising young author of antiquarian tastes to the literary world of Edinburgh, and the book was shortly followed by a sequel or companion, called *Walks in Edinburgh*, and published in 1825. Then, in 1826, came the *Popular Rhymes*, the *Picture of Scotland*, and numerous other works which appeared between 1826 and 1830 in *Constable's Miscellany.* In December, 1829, he took a still more important step, and was married to Miss Anne Kirkwood.

While Robert was thus busy, William was as active in his particular line as printer and publisher, not only of his brother's books, but of whatever other books were confided to him. Shortly after the *Traditions of Edinburgh* were completed, he gave up the mechanical occupation of a general printer and adhered rather to publishing and more distinctly literary undertakings. Thus he compiled, with great trouble and much personal research, a work which he called the *Book of Scotland.* When it was completed he sold it to a publisher for £30. This was a poor reward, but the immediate result was an order from another publisher to prepare the *Gazetteer of Scotland*, for which the price was to be £100. To do this properly William Chambers made several long pedestrian journeys through Scotland, in which, by exercising his old rigorous economy, his expenses did not exceed a few shillings a day. The *Gazetteer*, as it finally appeared in a thick octavo volume, in double columns and small type, was almost entirely the work of William Chambers, whose share of the sum paid for the copyright was £70. Thus the two brothers spent the interval between 1822 and 1832, the only drawback to their prosperity being an absurd scheme of their sanguine father, who entered into a lawsuit to recover some property to which he had an imaginary claim. It need not be said that he lost it, and that his sons, to save him from prison, had to pay the costs. Thus Robert lost a large part of the money he had realized by his *Traditions*, and William was crippled in his resources for two or three years. At last, in November, 1824, their father died, a wreck, sinking under misfortunes which he had brought upon himself by his want of foresight. His wife lived the rest of her days with her sons, and William and Robert were freed from demands, which had been a drag upon their rising fortunes.

In 1832 began the cheap Literature movement in the British Isles into which the two brothers threw themselves with characteristic energy. Their early struggles were over, their heroic age past, and their career became more prosperous but less interesting. In January, 1832, they issued the prospectus of *Chambers' Edinburgh Journal*, a weekly sheet at three-halfpence. Of this William was editor and publisher and printer, while Robert by his leading articles, which took the shape of moral, familiar, and humorous Essays, obtained for the new speculation a wide circulation. The success of the undertaking was far beyond the expectations of those who started it. In a few days the sale rose to 56,000, and at the third number, when the sale extended to England, 80,000 copies were sold. From that day forth *Chambers' Journal* continued a lasting success. The secret of its deserved popularity was no doubt owing to the energy and enterprise with which it was conducted, and to the great and varied ability displayed by Robert as a writer. In the words of William, "Robert and I had come through too many tribulations and seen too vividly the consequences of lost chances of well-doing among those about us, now to trifle with the opportunity of honourable advancement which had been fortunately placed in our way." The brothers continued the career so steadily and seriously begun with the same resolution and forbearance to the end. It is known to all, how the house of W. and R. Chambers of Edinburgh, became publishers in London also, and have always maintained a commanding position in the trade. It is known at least to many how Robert extended his literary labours into wider fields, and by turns enlightened and delighted his readers by his geological, scientific, and topographical writings. In 1863 he brought out his *Book of Days*, which proved a great success, but a great injury to his health. "That book has been my death blow," he was heard to say. Though he lived on and worked on he was never the same, and at last, on the 14th of March, 1871, in the 69th year of his age, he died very gently at St. Andrews, a victim as it seemed to himself and his family of that excessive literary labour which often proves so fatal by overtaxing the nervous system. Such is a very brief sketch of the life of one of the most genial and industrious men whom Scotland, rich in such characters, has ever produced.—*The Times.*

ON THE PLEASURE ARISING FROM VICISSITUDE.

Left unfinished by Gray. The additions by Mason, a poet, and friend of Gray, are distinguished by inverted commas.

Now the golden morn aloft
  Waves her dew-bespangled wing,
With blushing cheek and whisper soft
  She woos the tardy spring:
Till April starts, and calls around
The sleeping fragrance from the ground;
And lightly o'er the living scene
Scatters his freshest, tenderest green.

New-born flocks, in rustic dance,
  Frisking ply their feeble feet;
Forgetful of their wintry trance
  The birds his presence greet:
But chief, the sky-lark warbles high
His trembling thrilling ecstasy;
And, lessening from the dazzled sight,
Melts into air and liquid light.

Rise, my soul! on wings of fire,
  Rise the rapturous choir among;
Hark! 'tis nature strikes the lyre,
  And leads the general song:
"Warm let the lyric transport flow,
Warm as the ray that bids it glow,
And animates the vernal grove
With health, with harmony, and love."

Yesterday the sullen year
  Saw the snowy whirlwind fly;
Mute was the music of the air,
  The herd stood drooping by;

Their raptures now that wildly flow,
No yesterday nor morrow know;
'Tis man alone that joy descries
With forward, and reverted eyes.

Smiles on past misfortune's brow
  Soft reflection's hand can trace;
And o'er the cheek of sorrow throw
  A melancholy grace;
While hope prolongs our happier hour,
Or deepest shades, that dimly lower
And blacken round our weary way,
Gilds with a gleam of distant day.

Still, where rosy pleasure leads,
  See a kindred grief pursue;
Behind the steps that misery treads,
  Approaching comfort view;
The hues of bliss more brightly glow,
Chastised by sabler tints of woe;
And blended form, with artful strife,
The strength and harmony of life.

See the wretch, that long has tost
  On the thorny bed of pain,
At length repair his vigour lost,
  And breathe and walk again:
The meanest flow'ret of the vale,
The simplest note that swells the gale,
The common sun, the air, the skies,
To him are opening paradise.

Humble Quiet builds her cell,
  Near the source whence pleasure flows;
She eyes the clear crystalline well,
  And tastes it as it goes.
"While" far below the "madding" crowd
"Rush headlong to the dangerous flood,"
Where broad and turbulent it sweeps,
"And" perish in the boundless deeps.

Mark where Indolence and Pride,
"Soothed by flattery's tinkling sound,"
Go, softly rolling, side by side,
Their dull but daily round:
"To these, if Hebe's self should bring,
The purest cup from pleasure's spring,
Say, can they taste the flavour high
Of sober, simple, genuine joy?

"Mark Ambition's march sublime
Up to power's meridian height;
While pale-eyed Envy sees him climb,
And sickens at the sight.
Phantoms of danger, death, and dread,
Float hourly round Ambition's head;
While spleen, within his rival's breast,
Sits brooding on her scorpion nest.

"Happier he, the peasant, far
From the pangs of passion free,
That breathes the keen yet wholesome air
Of rugged penury.
He, when his morning task is done,
Can slumber in the noontide sun;
And hie him home, at evening's close,
To sweet repast, and calm repose.

"He, unconscious whence the bliss,
Feels, and owns in carols rude,
That all the circling joys are his,
Of dear Vicissitude.
From toil he wins his spirits light,
From busy day the peaceful night;
Rich, from the very want of wealth,
In heaven's best treasures, peace and health."

—*Gray.*

JAVANESE.

THESE people occupy about forty villages, scattered along the range of hills in the neighbourhood of what is termed the Sunda Sea. The site of their villages, as well as the construction of their houses, is peculiar, and differs entirely from what is elsewhere observed in Java. They are not shaded by trees, but built on spacious open terraces, rising one above the other, each house occupying a terrace, and being in length from thirty to forty, and even eighty feet. The door is invariably in one corner, at the end of the building opposite to that in which the fireplace is built. The building appears to be constructed with the ordinary roof, having along the front an enclosed verandah or gallery, about eight feet broad. The fireplace is built of brick, and is so highly venerated that it is considered a sacrilege for any stranger to touch it. Across the upper part of the building rafters are run, so as to form a kind of attic story, in which are deposited the most valuable property and implements of husbandry.

The head of the village takes the title of Peting'gi, as in the lowlands, and is generally assisted by a Kabâyan, both elected by the people from their own village. There are four priests who are here termed Dûkans, having charge of the State records and the sacred books.

These Dûkans, who are in general intelligent men, can give no account of the era when they were first established on these hills; they can produce no traditional history of their origin, whence they came, or who entrusted them with the sacred books, to the faith contained in which they still adhere. These, they concur in stating, were handed down to them by their fathers, to whose hereditary office of preserving them they have succeeded.

The sole duty required of them is again to hand them down in safety to their children, and to perform the "praisegiving" according to the directions they contain. These records consist of three compositions, written on the lantar-leaf, detailing the origin of the world, disclosing the attributes of the Deity, and describing the form of worship to be observed on different occasions.

When a marriage is agreed upon, the bride and bridegroom, being brought before the Dûkan within the house, in the first place bow with respect towards the south, then to the fireplace, then to the earth, and lastly, on looking up, to the upper story of the house where the implements are placed; the parties then submissively bowing to the Dûkan, he repeats a prayer, while the bride washes the feet of the bridegroom. At the conclusion of this ceremony, the friends and family of the parties make presents to each, of buffaloes, implements of husbandry, &c.; in return for which the bride and bridegroom respectfully present them with Betel leaf.

At the interment of an inhabitant of Teng'ger, the corpse is lowered into the grave with the head placed towards the south (contrary to the direction observed by the Mahometans), and is guarded from immediate contact with the earth by a covering of bamboos and planks. When the grave is closed, two posts are planted over the body: one erected perpendicularly over the breast, the other on the lower part of the belly; and between them is placed a hollow bamboo in an inverted position, into which during successive days they daily empty a vessel of pure water, laying beside the bamboo two dishes, also daily replenished with eatables. At the expiration of the seventh day, the feast of the dead is announced, and the relations and friends of the deceased assemble to be present at the ceremony, and to partake of entertainments conducted in the following manner:—

A figure of about half a cubit high, representing the human form, made of leaves and ornamented with variegated flowers, is prepared and placed in a conspicuous situation, supported round the body by the clothes of the deceased. The Dûkan then places in front of the garland an incense-pot with burning ashes, together with a vessel containing water, and repeats the two "praisegivings" to fire and water.

The clothes of the deceased are then divided among the relatives and friends; the garland is burned, another "praisegiving" is repeated; while the remains of the sacred water are sprinkled over the feast.

The parties now sit down to the enjoyment of the feast, invoking a blessing from the Almighty on themselves, their houses, and their lands.

No more solemnities are observed till the expiration of a thousand days; when, if the memory of the deceased is loved and cherished, the ceremony and feast are repeated, if otherwise, no further notice is taken of him; and having thus obtained what the Romans called his "Justa," he is allowed to be forgotten.—*Phillips' Guide to the Crystal Palace.*

THE BATTLE OF PHARSALIA, (B.C. 48).

Cæsar had employed all his art for some time in sounding the inclinations of his men; and finding them once more resolute and vigorous, he advanced towards the plains of Pharsalia, where Pompey was encamped. The approach of the two armies, composed of the best and bravest troops in the world, together with the greatness of the prize for which they contended, filled every mind with anxiety, though with different expectations. Pompey's army being most numerous, turned all their thoughts to the enjoyment of victory; Cæsar's, with better aim, considered only the means of obtaining it. Pompey's army depended upon their numbers and their many generals; Cæsar's upon their discipline and the conduct of their single commander. Pompey's partizans hoped much from the justice of their cause; Cæsar's alleged the frequent proposals, which they had made for peace without effect. Thus the views, hopes, and motives of both seemed different, while their hatred and ambition were the same. Cæsar, who was ever foremost in offering battle, led out his army to meet the enemy; but Pompey, either suspecting the troops or dreading the event, kept his advantageous position at the foot of the hill near which he was posted. Cæsar, unwilling to attack him at a disadvantage, resolved to decamp the next day, hoping to weary out his antagonist, who was not a match for him in sustaining the fatigues of duty. Accordingly, the order for marching was given, and the tents struck, when word was brought him that Pompey's army had now quitted their entrenchments, and advanced farther into the plain than usual; so that he might engage them at less disadvantage. Upon this, he caused his troops to halt, and with a countenance of joy informed them, that the happy time was at last come, for which they had so long wished, and which was to crown their glory and terminate their fatigues. He drew up his troops in order, and advanced towards the place of battle. His forces did not amount to half those of Pompey: the army of the one was about forty-five thousand foot and seven thousand horse; that of the other, not exceeding twenty-two thousand foot, and about a thousand horse. This proportion, particularly in the cavalry, had filled Cæsar with apprehensions: he therefore had, some days before, picked out the strongest and nimblest of his foot-soldiers, and accustomed them to fight between the ranks of his cavalry. By their assistance, his thousand horse was a match for Pompey's seven thousand, and had actually got the better in a skirmish that happened between them some days before. Pompey, on the other hand, had a strong expectation of success; he boasted that he could put Cæsar's legions to flight without striking a single blow; presuming that, as soon as the armies formed, his cavalry, on which he placed his greatest expectations, would outflank and surround the enemy. In this disposition Pompey led his troops to battle.

As the armies approached, the two generals went from rank to rank encouraging the men, warming their hopes, and lessening their apprehensions.

There was no more space between both armies than to give room for fighting. Pompey, therefore, ordered his men to receive the first shock without moving from their places, expecting the enemy's ranks to be put into disorder. Cæsar's soldiers were now rushing on with their usual impetuosity, when, perceiving the enemy motionless, they all stopped short, as if by general consent, and halted in the midst of their career.

A terrible pause ensued, in which both armies continued to gaze upon each other with mutual terror and dreadful serenity. At length, Cæsar's men having taken breath, ran furiously upon the enemy, first discharging their javelins, and then drawing their swords. The same method was observed by Pompey's troops, who as firmly had sustained the attack.

His cavalry also were ordered to charge at the very onset; which, with the multitude of archers and slingers, soon obliged Cæsar's men to give ground. Cæsar instantly ordered the six cohorts, that were placed as a re-inforcement, to advance, and to strike at the enemy's faces. This had its desired effect. Pompey's cavalry, that were just before sure of victory, received an immediate check. The unusual method of fighting pursued by the cohorts, their aiming entirely at the visages of the assailants, and the horrible disfiguring wounds they made, all contributed to intimidate them so much, that, instead of defending their persons, they endeavoured only to save their faces.

A total rout ensued: they fled to the neighbouring mountains, while the archers and slingers, who were thus abandoned, were cut to pieces.

Cæsar now commanded the cohorts to pursue their success, and charge Pompey's troops upon the flank: this charge the enemy withstood for some time, till Cæsar brought up his third line, which had not yet engaged. Pompey's infantry being thus doubly attacked,—in front by fresh troops, and in rear by the victorious cohorts,—could no longer resist, but fled to their camp.

The flight began among the strangers. Pompey's right wing still valiantly maintained its ground. Cæsar, however, convinced that the victory was certain, with his usual clemency cried out to pursue the strangers, but to spare the Romans; upon which they all laid down their arms and received quarter.

The greatest slaughter was among the auxiliaries, who fled on all sides. The battle had now lasted from break of day till noon: the weather was extremely hot; nevertheless, the conquerors remitted not their ardour, being encouraged by the example of a general, who thought his victory incomplete till he should become master of the enemy's camp. Accordingly, marching on foot at their head, he called upon them to follow and strike the decisive blow.

The cohorts, which were left to defend the camp, for some time made a formidable resistance, particularly a great number of Thracians and other barbarians, who were appointed for that purpose; but nothing could resist the ardour of Cæsar's victorious army; the enemy were at last driven from the trenches, and they all fled to the mountains. Cæsar, seeing the field and camp strewn with his fallen countrymen, was strongly affected at the melancholy prospect, and cried out to one that stood near, "They would have it so."

—*Goldsmith's History of Rome.*

SCENE FROM "JULIUS CÆSAR."

BY SHAKESPEARE.

BRUTUS. MARK ANTONY. CITIZENS.

Brutus. Romans, countrymen, and lovers! hear me for my cause; and be silent, that you may hear: believe me for mine honour; and have respect to mine honour, that you may believe: censure me in your wisdom; and awake your senses, that you may the better judge. If there be any in this assembly, any dear friend of Cæsar's, to him I say, that Brutus' love to Cæsar was no less than his. If then that friend demand why Brutus rose against Cæsar, this is my answer,—Not that I loved Cæsar less, but that I loved Rome more. Had you rather Cæsar were living, and die all slaves; than that Cæsar were dead, to live all free-men? As Cæsar loved me, I weep for him; as he was fortunate, I rejoice at it; as he was valiant, I honour him: but, as he was ambitious, I slew him· there are tears, for his love; joy, for his fortune; honour, for his valour; and death, for his ambition. Who is here so base that would be a bondman? If any, speak; for him have I offended. Who is here so rude that would not be a Roman? If any, speak; for him have I offended. Who is here so vile that will not love his country? If any, speak; for him have I offended. I pause for a reply.

Citizens. None, Brutus, none.

[*Several speaking at once.*

Bru. Then none have I offended. I have done no more to Cæsar than you shall do to Brutus. The question of his death is enrolled in the Capitol: his glory not extenuated, wherein he was worthy; nor his offences enforced, for which he suffered death.

Enter ANTONY *and others, with* CÆSAR'S *body.*

Here comes his body, mourned by Mark Antony; who, though he had no hand in his death, shall receive the benefit of his dying, a place in the commonwealth. As which of you shall not? With this I depart: that, as I slew my best lover for the good of Rome, I have the same dagger for myself, when it shall please my country to need my death.

Cits. Live, Brutus, live! live!

1st. *Cit.* Bring him with triumph home unto his house.

2nd. *Cit.* Give him a statue with his ancestors.

3rd. *Cit.* Let him be Cæsar.

ANTONY'S *funeral oration over the body of* JULIUS CÆSAR.

Ant. Friends, Romans, countrymen, lend me your ears;
I come to bury Cæsar, not to praise him.
The evil that men do lives after them;
The good is oft interred with their bones;

So let it be with Cæsar. The noble Brutus
Hath told you, Cæsar was ambitious;
If it were so, it was a grievous fault;
And grievously hath Cæsar answer'd it.
Here, under leave of Brutus, and the rest,
(For Brutus is an honourable man;
So are they all, all honourable men;)
Come I to speak in Cæsar's funeral.
He was my friend, faithful and just to me:
But Brutus says he was ambitious;
And Brutus is an honourable man.
He hath brought many captives home to Rome,
Whose ransoms did the general coffers fill:
Did this in Cæsar seem ambitious?
When that the poor have cried, Cæsar hath wept:
Ambition should be made of sterner stuff:
Yet Brutus says he was ambitious;
And Brutus is an honourable man.
You all did see that on the Lupercal
I thrice presented him a kingly crown,
Yet he did thrice refuse. Was this ambition?
Yet Brutus says he was ambitious;
And, sure, he is an honourable man.
I speak not to disprove what Brutus spoke,
But here I am to speak what I do know.
You all did love him once, not without cause;
What cause withholds you then to mourn for him?
O, judgment, thou art fled to brutish beasts,
And men have lost their reason!—Bear with me;
My heart is in the coffin there with Cæsar,
And I must pause till it come back to me.
But yesterday the word of Cæsar might
Have stood against the world: now lies he there,
And none so poor to do him reverence.
O masters, if I were dispos'd to stir
Your hearts and minds to mutiny and rage,
I should do Brutus wrong, and Cassius wrong,
Who, you all know, are honourable men:
I will not do them wrong; I rather choose
To wrong the dead, to wrong myself, and you,

Than I will wrong such honourable men.
But here's a parchment, with the seal of Cæsar,
I found it in his closet, 'tis his will:
Let but the commons hear this testament,
(Which, pardon me, I do not mean to read,)
And they would go and kiss dead Cæsar's wounds,
And dip their napkins in his sacred blood;
Yea, beg a hair of him for memory,
And, dying, mention it within their wills,
Bequeathing it as a rich legacy,
Unto their issue.
4th. *Cit.* We'll hear the will: Read it, Mark Antony.
Cits. The will, the will! we will hear Cæsar's will.
Ant. Have patience, gentle friends, I must not read it;
It is not meet you know how Cæsar loved you.
You are not wood, you are not stones, but men;
And, being men, hearing the will of Cæsar,
It will inflame you, it will make you mad:
'Tis good you know not that you are his heirs;
For if you should, O, what would come of it!
4th. *Cit.* Read the will; we'll hear it, Antony; you *shall* read us the will; Cæsar's will!
Ant. Will you be patient? Will you stay awhile?
I have o'ershot myself to tell you of it.
I fear I wrong the honourable men
Whose daggers have stabb'd Cæsar: I do fear it.
4th. *Cit.* They were traitors: Honourable men!
Cits. The will! the testament!
2nd. *Cit.* They were villians, murderers: The will! read the will!
Ant. You will compel me, then, to read the will?
Then make a ring about the corpse of Cæsar,
And let me shew you him that made the will.
Shall I descend? and will you give me leave?
Cits. Come down.
Ant. If you have tears, prepare to shed them now.
You all do know this mantle: I remember
The first time ever Cæsar put it on;
'Twas on a summer's evening, in his tent,

That day he overcame the Nervii:—
Look! in this place ran Cassius' dagger through:
See, what a rent the envious Casca made:
Through this, the well-beloved Brutus stabb'd;
And, as he pluck'd his cursèd steel away,
Mark how the blood of Cæsar follow'd it,
As rushing out of doors, to be resolv'd
If Brutus so unkindly knock'd or no;
For Brutus, as you know, was Cæsar's angel:
Judge, O you gods, how dearly Cæsar lov'd him!
This was the most unkindest cut of all:
For when the noble Cæsar saw him stab,
Ingratitude, more strong than traitors' arms,
Quite vanquish'd him: then burst his mighty heart.
And, in his mantle muffling up his face,
Even at the base of Pompey's statue,
Which all the while ran blood, great Cæsar fell.
O what a fall was there, my countrymen!
Then I, and you, and all of us fell down,
Whilst bloody treason flourish'd over us.
O, now you weep; and, I perceive, you feel
The dint of pity: these are gracious drops.
Kind souls, what weep you, when you but behold
Our Cæsar's vesture wounded? Look you here,
Here is himself, marr'd, as you see, with traitors.

1st. *Cit.* O piteous spectacle!

2nd. *Cit.* O noble Cæsar!

3rd. *Cit.* O woeful day!

4th. *Cit.* O traitors, villians!

1st. *Cit.* O most bloody sight!

Cits. We will be revenged; revenge; about,—seek,—burn,—fire,—kill,—slay!—let not a traitor live.

Ant. Stay, countrymen.

1st. *Cit.* Peace there:—Hear the noble Antony.

2nd. *Cit.* We'll hear him, we'll follow him, we'll die with him.

Ant. Good friends, sweet friends, let me not stir you up
To such a sudden flood of mutiny.
They that have done this deed are honourable;

What private griefs they have, alas! I know not,
That made them do it; they are wise and honourable,
And will, no doubt, with reasons answer you.
I come not, friends, to steal away your hearts;
I am no orator, as Brutus is;
But as you know me all, a plain, blunt man,
That love my friend; and that they know full well,
That gave me public leave to speak of him.
For I have neither wit, nor words, nor worth,
Action, nor utterance, nor the power of speech,
To stir men's blood: I only speak right on;
I tell you that which you yourselves do know;
Shew you sweet Cæsar's wounds, poor, poor dumb mouths,
And bid them speak for me: But were I Brutus,
And Brutus Antony, there were an Antony
Would ruffle up your spirits, and put a tongue
In every wound of Cæsar, that should move
The stones of Rome to rise and mutiny.

SUMATRANS.

THE populations of Sumatra exhibit different degrees of civilization to an extent found in few areas of equal size: the difference in their religious creeds being proportionately broad. There are the extreme forms of rude paganism; there are traces of the Indian forms of religion; and there is Mahometanism. There are the Lubus, one of the wildest, rudest, and weakest of all the populations. The position of the Lubus in Sumatra is that of the Bushmen of South Africa, for they are a fragmentary population, driven into the more inaccessible districts by tribes stronger than themselves; without arts and without settled habitations.

The next are Battas, whose civilization is some degrees above that of the Lubu. A great part of their present area belonged to this last named population, who are, probably, Battas in the very lowest stage of development. These require further notice. They belong to the northern half of Sumatra, though without reaching the northern extremity of the island.

The rivers in the Batta country are inconsiderable, so are the forests, for the country is an elevated platform—dry, exposed, and parched.

The luxuriant vegetation of so many regions in this part of the world, finds no place here; and instead of it, we have sand, hardened clay, bare rocks swept by strong currents of wind and exposed to an equatorial sun.

The Battas are cannibals; they are also a lettered population. It is believed that this combination of rudeness and civilization occurs nowhere else, a combination which, however, is beyond doubt.

On the Batta cannibalism, hear so competent an authority as Marsden. "They," the Battas, "do not eat human flesh as the means of satisfying the cravings of nature, for there can be no want of sustenance to the inhabitants of such a country and climate, who reject no animal food of any kind; nor is it sought after as a gluttonous delicacy.

"The Battas eat it as a species of ceremony, as a mode of shewing their detestation of certain crimes by an ignominious punishment, and as a savage display of revenge and insult to their unfortunate enemies. The objects of this barbarous repast are prisoners taken in war, (especially if badly wounded,) the bodies of the slain, and offenders condemned for certain capital crimes, especially for adultery. Prisoners unwounded (but they are not much disposed to give quarter) may be ransomed or sold as slaves, where the quarrel is not inveterate; and the convicts, there is reason to believe, rarely suffer when their friends are in circumstances to redeem them by the customary equivalent of eighty dollars. These are tried by the people of the tribe where the offence was committed, but cannot be executed until their own particular rajah has been made acquainted with the sentence, who, when he acknowledges the justice of the intended punishment, sends a cloth to cover the head of the delinquent, together with a large dish of salt and lemons. The unhappy victim is then delivered into the hands of the injured party (if it be a private wrong, or, in the case of a prisoner, to the warriors) by whom he is tied to a stake, lances are thrown at him from a certain distance by this person, his relatives, and friends; and when mortally wounded, they run up to him, as if in a transport of passion, cut pieces from the body with their knives, dip them in the dish of salt, lemon juice, and red pepper, slightly broil them over a fire prepared for the purpose, and swallow the morsels with a degree of savage enthusiasm. Sometimes the whole is devoured by the bystanders; and instances have been known where, with barbarity still more aggravated, they tear the flesh from the carcase with their teeth. To such a depth of depravity may man be plunged, when neither religion nor philosophy enlighten his steps."

All that can be said in extenuation of the horror of this diabolical ceremony is, that no view appears to be entertained of torturing the sufferers, of increasing or lengthening out the pains of death; the whole fury is directed against the corpse, warm, indeed, with the remains of life, but past the sensation of pain.

A difference of opinion has existed with regard to the practice of eating the bodies of their enemies actually slain in war; but subsequent enquiry has proved the fact, especially in the case of distinguished persons, or those who have been accessories to the quarrel.

It should be mentioned that their campaigns often terminate with the loss of not more than half-a-dozen men on both sides. The skulls of the victims are hung up as trophies in the open buildings in front of their houses, and are occasionally ransomed by their surviving relations for a sum of money.—*Phillip's Guide to the Crystal Palace.*

THE WATERFALL AT PUPPANASSUM.

Before we left Tinevelly, we took the opportunity of visiting the waterfall at Pup-pa-nas-sum, which is perhaps, upon the whole, the most stupendous object of its kind in the Car-na-tic. The approach to it lay through a long narrow valley, at the termination of which the fall deposits its waters in an unfathomable pool, whence a new river seems to issue, winding its placid course through a plain nearly level with the sea. Upon our approach to the fall through this valley, confined on either side by lofty hills, the view of it was frequently obstructed by the intersections of the mountain round which we occasionally had to wind. We followed the winding course of the stream, along the banks of which we saw a great number of devotees on their way to bathe in those sacred waters, and to offer their genuflexions and prostrations upon a spot consecrated at once by extreme antiquity and very awful local traditions. These slaves of the most besotted superstitions upon earth, did not appear to be at all pleased with the idea of seeing the place profaned by the unhallowed feet of Christians, whom they hold in absolute abhorrence.

They passed us in dogged silence, and there was an expression of malignant scorn upon the curl of those lips, which were about to offer up their devotions to gods more abominable than themselves, that satisfied us they wanted not the will, though they lacked the daring, to do us a mischief. Alas! that devotion should have such votaries!

No one, who has witnessed the stern ferocity of feeling encouraged by the deluded supporters of a most extravagant idolatry towards all of a different creed, can well shut out the reflection of his own moral advantages, and fail to bless his God, with most earnest sincerity of purpose, that he was born a member of a Christian community.

Upon turning the angle of a hill which rose abruptly from the valley, the fall burst suddenly upon our sight.

It was indeed a magnificent spectacle. The impression excited was so uncommon, that I was obliged to close my eyes for a moment, in order to recover from the sudden and almost astounding surprise. Though the roar of the cataract had been heard long before we reached it, so that we were not unprepared for something more than commonly imposing, the reality far surpassed our expectations.

It is precipitated from a height of 150 feet, pouring over the steep a prodigious body of water which, forcing its way among the intervening rocks, among which it boils and hisses with tremendous fury, falls into the deep, dark pool beneath, with a din and turbulence that are almost deafening.

The sound of the cataract may be heard at the distance of several miles, even in the dry season; but during the monsoons, when swelled by mountain torrents, the roar is augmented tenfold. There is a tremendous vortex just below the fall, caused by its sudden and violent pressure upon the surface below, so that no one can safely approach within reach of the spray. The waters of this spot are highly sacred. Puppanassum, the name which the place bears, signifies the "washing away of sins;" and a great number of devotees are to be seen at all times bathing in this consecrated river.—*Saturday Magazine.*

TAKING OF TROY.

BURNING THE CITY.

Now peals of shouts come thundering from afar,
Cries, threats, and loud laments, and mingled war:
The noise approaches, though our palace stood
Aloof from streets, encompassed with a wood..
Louder, and yet more loud, I hear the alarms
Of human cries distinct, and clashing arms.
Fear broke my slumbers; I no longer stay,
But mount the terrace, thence the town survey,
And hearken what the frightful sounds convey.

Thus, when a flood of fire by wind is borne,
Crackling it rolls, and mows the standing corn;
Or deluges, descending on the plains,
Sweep o'er the yellow year, destroy the pains
Of labouring oxen and the peasant's gains;
Unroot the forest oaks, and bear away
Flocks, folds, and trees, an undistinguished prey:
The shepherd climbs the cliffs, and sees from far
The wasteful ravage of the watery war.
Then Hector's faith was manifestly cleared;
And Grecian frauds in open light appeared.
The palace of Deïphobus ascends
In smoky flames and catches on his friends.
Ucalegon burns next; the seas are bright
With splendour not their own, and shine with Trojan light.
New clamours and new clangors now arise,
The sound of trumpets mixed with fighting-cries.
With frenzy seized, I run to meet the alarms,
Resolved on death, resolved to die in arms,
But first to gather friends, with them t' oppose
(If fortune favoured) and repel the foes—
Spurred by my courage, by my country fired,
With sense of honour and revenge inspired.

THE SLAUGHTER.

"Brave souls," said I, "but brave, alas! in vain,
Come, finish what our cruel fates ordain.
You see the desperate state of our affairs:
And heaven's protecting powers are deaf to prayers.
The passive gods behold the Greeks defile
Their temples, and abandon to the spoil
Their own abodes; we, feeble few, conspire
To save a sinking town, involved in fire.
Then let us fall, but fall amidst our foes;
Despair of life the means of living shews."
So bold a speech encouraged their desire
Of death, and added fuel to their fire.

As hungry wolves, with raging appetite,
Scour through the fields, nor fear the stormy night;
Their whelps at home expect the promised food,
And long to temper their dry chaps in blood:
So rushed we forth at once, resolved to die,
Resolved in death the last extremes to try.
We leave the narrow lanes behind, and dare
The unequal combat in the public square;
Night was our friend, our leader was despair.
What tongue can tell the slaughter of that night?
What eyes can weep the sorrows and affright?
An ancient and imperial city falls;
The streets are filled with frequent funerals;
Houses and holy temples float in blood;
And hostile nations make a common flood.
Not only Trojans fell, but in their turn
The vanquished triumph, and the victors mourn.
Ours take new courage from despair and night;
Confused the fortune is, confused the fight.
All parts resound with tumults, plaints, and fears,
And grisly death in sundry shapes appears.

STORMIMG THE PALACE OF PRIAM.

Pyrrhus, among the foremost, deals his blows,
And with his axe repeated strokes bestows
On the strong doors: then all their shoulders ply,
Till from the posts the brazen hinges fly.
He hews apace: the double bars at length
Yield to his axe, and unresisted strength.
A mighty breach is made; the rooms concealed
Appear, and all the palace is revealed,
The halls of audience, and of public state,
And where the lonely queen in secret sate.
Armed soldiers now by trembling maids are seen,
With not a door, and scarce a space between.
The house is filled with loud laments and cries;
And shrieks of women rend the vaulted skies.
The fearful matrons run from place to place,

And kiss the thresholds, and the posts embrace.
The fatal work inhuman Pyrrhus plies;
And all his father* sparkles in his eyes.
Nor bars nor fighting guards his force sustain:
The bars are broken, and the guards are slain.
In rush the Greeks, and all the apartments fill;
Those few defendants whom they find, they kill.
Not with so fierce a rage the foaming flood
Roars, when he finds his rapid course withstood,
Bears down the dams with unresisted sway,
And sweeps the cattle and the cots away.
  Perhaps you may of Priam's fate inquire.
He, when he saw his regal town on fire,
His ruined palace, and his entering foes,—
On every side inevitable woes;
In arms disused invests his limbs, decayed
Like them with age; a late and useless aid.
His feeble shoulders scarce the weight sustain;
Loaded, not armed, he creeps along with pain,
Despairing of success, ambitious to be slain!
Uncovered but by heaven, there stood in view
An altar; near the hearth a laurel grew,
Dodder'd with age, whose boughs encompass round
The household gods, and shade the holy ground.
Here Hecuba, with all her helpless train
Of dames, for shelter sought, but sought in vain.
Driven like a flock of doves along the sky,
Their images they hug, and to their altars fly.
The queen, when she beheld her trembling lord,
And hanging by his side a heavy sword,
"What rage," she cried, "has seized my husband's mind?
What arms are these, and to what use designed?
These times want other aids! Were Hector here,
Even Hector now, in vain like Priam, would appear.
With us one common shelter thou shalt find,
Or in one common fate with us be joined."

---

* His father was the celebrated Achilles.

DEPARTURE OF ÆNEAS.

Armed once again, my glittering sword I wield,
While my other hand sustains my weighty shield;
And forth I rush to seek the abandoned field.
I went: but sad Creüsa stopped my way,
And 'cross the threshold in my passage lay,
Embraced my knees, and, when I would have gone,
Shewed me my feeble sire, and tender son.
"If death be your design, at least," said she,
"Take us along, to share your destiny.
If any farther hopes in arms remain,
This place, these pledges of your love, maintain.
To whom do you expose your father's life,
Your son's, and mine, your now forgotten wife?"
While thus she fills the house with clamorous cries,
Our hearing is diverted by our eyes:
For, while I held my son, in the short space
Betwixt our kisses and our last embrace,
(Strange to relate!) from young Iülus' head,
A lambent flame arose, which gently spread
Around his brows, and on his temples fed.
Amazed, with running water we prepare
To quench the sacred fire, and slake his hair;
But old Anchises, versed in omens, reared
His hands to heaven, and this request preferred:
"If any vows, almighty Jove, can bend
Thy will, if piety can prayers commend;
Confirm the glad presage which thou art pleased to send."
Scarce had he said, when on our left we hear
A peal of rattling thunder roll in air:
There shot a streaming lamp along the sky,
Which on the wingèd lightning seemed to fly:
From o'er the roof the blaze began to move,
And, trailing, vanished in the Idæan grove.
It swept a path in heaven, and shone a guide,
Then in a steaming stench of sulphur died.

Dryden's Virgil.

GARDENING.

It must not be supposed that the employment of hand-labour in gardening is solely determined by the circumstance of the size of the ground not admitting the use of the plough; for an easy remedy would instantly suggest itself in this case—that of increasing the area of land cultivated for gardens, or what is equivalent, uniting several small gardens into one large one. The true cause of the necessity for digging with a spade, instead of ploughing, is, that the plough is inadequate to bring the soil into such a state as is necessary for raising the proper produce of a garden with the least quantity of subsequent labour.

The greater part of the vegetables raised in gardens are either exotics from warmer climates, or indigenous plants improved by careful tillage bestowed on successive generations of them for many centuries; and if this care were not constantly employed, the plants in their improved state would not be able to bear the comparative rigour of our climate, but would speedily degenerate to their original or natural state.

The chief object of all tillage is to supply the growing plants with constant nourishment by the frequent moving of the soil about them, and also to prevent their being robbed of that food by weeds growing among them. The operations required to effect these objects can only be carried on when the plants are placed with great regularity in straight lines; and that each plant may be accessible, they must be planted in small patches, or beds, of earth, with walks between them. Instead of sowing the seed of many vegetables in drills, and afterwards rooting up the superabundant plants, (the mode of cultivating turnips in fields,) it is productive of more economy both of seed and time, as well as of more benefit to their subsequent growth, to sow the seed closely in a small patch of ground, and to transplant the young plants when arrived at a certain age. By this means they may not only be planted in their proper beds with the utmost regularity, but there is also another motive for adopting this plan.

Every plant has particular seasons, at which, when growing in its native soil or in its native climate, the various stages of its development take place, and if transferred to a less genial situation, it must be sheltered during its infancy from the severity of the air; added to which, these successive stages of growth in all plants may be accelerated within certain limits by the application of artificial heat, in order to promote the germination of the seed and its early and rapid growth. This is a desirable object, in order to meet the demands of those who, having the means of purchasing luxuries, furnish the remuneration due to those who employ their care and skill in raising early produce by forced cultivation.

The artificial heat is applied in various manners, according to the vegetable, and to the mode of its growth, but the premature germination of the seed is effected by sowing it on a hot-bed, which is prepared in the following manner. Stable-litter (or straw which has been saturated with the dung, &c., of horses and cattle) is piled with care and regularity into a square heap flat at the top. The fermentation, which speedily ensues in such a mixture of animal and vegetable matter, evolves a quantity of heat, which is maintained and confined by the magnitude of the mass: on this heap fine mould is strewed, to the depth of seven or eight inches, and on the whole a frame is put, which is covered over with matting, or, if intended to be permanent, with glass lights. The seed being sown in this mould, the heat confined by the frame excites germination and produces rapid growth in the plant. When strong enough to bear the open air, to which they must be gradually habituated, the young plants are taken up with every care, that the fine fibres of their roots may not be injured, and they are then planted in the bed in the following manner:—

The earth being broken fine by digging and raking, a line is set out by means of a string stretched between two pegs or iron pins, and the gardener, taking the plant in his left hand, with the dibble in his right, he makes a perpendicular hole about six or eight inches deep; into this hole he lets the root of the plant descend, till the junction of the stem and root, or the neck of the plant, is level with the ground. He then pushes in the fine earth to fill up the hole again, and putting the dibble in obliquely at a small distance from the plant, by a twist of the tool presses the mould close up to the root. Without this precaution the plant would die, if the fine fibres of the root, instead of being in close contact with the earth, were left in the gaps of the loose pieces.

The plants, after this removal, will languish for a day or two, particularly if the weather be hot and dry; but they will then revive and grow with increased vigour, in consequence of the greater space from which their roots can derive nourishment. Plants should never be planted out in wet weather, or when the earth is wet from recently fallen rain, for the mould in this state would, after being worked, harden into a mortar which the fibres of the roots could never penetrate. When it is practicable, the operation should be performed just before rain when the earth is too dry for it to adhere at all in clods under the hoe or spade.

As soon as possible after the transplanting, when the recently moved plants begin to grow again, the earth should be hoed or dug between them, and, if necessary, a little should be drawn up the stems. Weeds must always be eradicated, or hoed down by the Dutch or thrust-hoe as soon as they appear; and once or twice at least during the growth of the plants the earth between them should be dug deeply, except the plants are vegetables cultivated for their tap-roots, as carrots, parsnips, beet, &c., or are bulb-bearing, as onions, leeks, &c. If the earth were dug deeply between the former class of plants, the roots would fork, or throw out side shoots, instead of growing straight or undivided; and the last-named kind of plants would, in such a case, not form large and full bulbs, but would run to neck.

Many kinds of vegetables will not admit of transplanting, but the seed must be sown thinly, in straight and equidistant drills; and when the young plants are fairly out of the ground, they must be thinned out by the hoe or by hand, leaving single plants only at such distances apart as they will require to be at when they are fully grown. It should be mentioned here, that nothing is so bad for plants as allowing them to be too close together; more produce, whether it be in roots, leaves, or fruit, is obtained from fine healthy plants that have had sufficient room to grow in, than from twice their number grown in the same space, and, consequently, crowded together.

Peas, *scarlet-beans*, and other climbing-plants, require sticks to be put to them to climb up; the sticks used for this purpose are the loppings of young trees, cuttings of underwood, &c., with the smaller branches and twigs left on; these sticks are set on each side of the row of peas, and are set sloping in contrary directions, thus forming a lattice-work, which furnishes support for every shoot to mount up by means of its tendrils.

Celery is blanched by planting the young plants at the bottom of trenches, dug twelve or eighteen inches deep; in proportion as the celery grows, the earth, which was taken out of the trenches, is put back again with care that it may not get into the heart of the plants.

The stems growing thus underground, or kept from the light and air, remain white, or do not acquire the green hue of plants exposed to the light of the sun. In consequence of this mode of proceeding, when the celery has finished growing, and is ready for use, it will be found buried in the centre of elevated ridges, the intermediate furrows being caused by the removal of the earth to form these. The plants are dug out as wanted.

Sea Kale is blanched by remaining constantly covered during its growth by earthenware pots, made tall expressly for this purpose. The pots have a small cover which takes off, to allow of the progress of the kale being examined.

Plants that grow early in the spring, or which are prematurely brought forward by forcing on hot beds, require to be sheltered on the approach of frost. A very slight covering is sufficient in many cases, straw litter or fern leaves even being enough to prevent the radiation of heat from the earth, and when, in addition to these, mats of bass are spread over them, the frost must be severe that can penetrate to the plants beneath.

Single plants are sheltered by covering them over with garden pots, or with hand-glasses, small frames made of lead or iron, in which panes of glass are inserted, as the casements of cottages are glazed.—*Saturday Magazine.*

SCENE FROM "ROMEO AND JULIET."

MERCUTIO. ROMEO.

Mercutio. O, then, I see Queen Mab hath been with you,
She is the fairies' midwife; and she comes
In shape no bigger than an agate stone
On the fore-finger of an alderman,
Drawn with a team of little atomies
Athwart men's noses as they lie asleep:
Her waggon-spokes made of long spinners' legs,
The cover, of the wings of grasshoppers;
The traces of the smallest spider's web;
The collars of the moonshine's watery beams;
Her whip of cricket's bone; the lash of film:
Her waggoner a small grey-coated gnat,
Not half so big as a round little worm
Prick'd from the lazy finger of a maid:
Her chariot is an empty hazel-nut,
Made by the joiner squirrel, or old grub,
Time out o' mind the fairies' coach-makers.
And in this state she gallops night by night
Through lovers' brains, and then they dream of love;

O'er courtiers' knees, that dream on court'sies straight:
O'er lawyers' fingers, who straight dream on fees:
O'er ladies' lips, who straight on kisses dream:
Which oft the angry Mab with blisters plagues,
Because their breaths with sweetmeats tainted are.
Sometime she gallops o'er a courtier's nose,
And then dreams he of smelling out a suit:
And sometime comes she with a tithe-pig's tail,
Tickling a parson's nose as 'a lies asleep,
Then dreams he of another benefice:
Sometime she driveth o'er a soldier's neck,
And then dreams he of cutting foreign throats,
Of breaches, ambuscadoes, Spanish blades,
Of healths five fathom deep; and then anon
Drums in his ear: at which he starts, and wakes;
And, being thus frighted, swears a prayer or two,
And sleeps again. This is that very Mab,
That plats the manes of horses in the night;
And bakes the elf-locks in foul sluttish hairs,
Which, once untangled, much misfortune bodes—
Romeo. Peace, peace, Mercutio, peace,
Thou talk'st of nothing.
Mer. True, I talk of dreams,
Which are the children of an idle brain,
Begot of nothing but vain fantasy;
Which is as thin of substance as the air;
And more inconstant than the wind who wooes
Even now the frozen bosom of the north,
And, being anger'd, puffs away from thence,
Turning his face to the dew-dropping south.
—*Shakespeare.*

THE PRINCIPAL GARDEN VEGETABLES WHICH SERVE FOR FOOD.

THE great variety of vegetable productions, which serve as food to man, speaking specially of those which he cultivates, may be classed under a few great divisions, conformably both with their botanical characters, and with the part of the plant which is consumed. Though there is no part of a plant which, in different species, is not eaten, yet, as forming a considerable portion of his diet, it will be found that it is either the root, the stem, the leaves, or the fruit, that man makes use of, while the bark, the seed, the flowers, the bud, &c., of other species, are commonly used as condiments or sauces.

Next to the Cerealia, the seeds of that order of plants, called from their fruit, Leguminous, contain the greatest proportion of farina. The pea and the bean are the principal kinds of this order, employed by man as food in Europe.

The Pea is a climbing annual plant with a white flower; the seed in its green or unripe state, constitutes a favourite dish, but for this purpose it is cultivated as a garden vegetable, while agriculture can alone furnish the ripe seed in sufficient quantities to supply the demand for dry peas in the navy, in hospitals, &c.

The pea requires warm soil, the crop is gathered when the pod is quite ripe and dry, the seed is thrashed out, the stalks and leaves (or the haulm) is sometimes given to the cattle as fodder.

The seed of the pea tribe divides into two more readily than most seeds, containing two seed leaves. Split peas are produced by grinding the seed tightly between millstones or plates of iron, in mills constructed for the purpose; this operation frees the germ of the seeds from the skin or coats, and also separates the former into the two portions, each of which consists of an undeveloped seed.

The Bean.—This name is given to different species of plants, though all belonging to the Leguminous order. The broad bean, of which the unripe seed alone is eaten as a vegetable, is a species of the genus Vetch, an annual growing to the height of from two to three feet, which, unlike the other species, is not a climbing plant. The delightful fragrance of its black and white flowers is familiar to every one; but the principal use of this bean, when ripe, is as fodder for horses, cattle, hogs, and poultry. The French or Haricôt bean is a dwarf species, and the scarlet runner in Britain (one of the most universally cultivated of all garden vegetables) is another species of the same genus. The whole pod, or fruit of these plants, is eaten before it is ripe.

Both are of the easiest culture, but they must not be sown till all danger of frost is over. There are numerous varieties, and some of these are cultivated for food in nearly every country of the world where gardening is practised.

The Tare and the *Lentil* are species of the genus Ervum, and are used as food in some continental countries, but in England they are only cultivated as fodder.

The Leguminous order contains but few positively unwholesome or poisonous kinds; but among these, the Laburnum is best known for its beautiful flowers, which are such universal favourites.

The Potato belongs to a family of plants, almost every one of which is, in a greater or less degree, poisonous. The noxious principles generally abound in the fruit or leaves, while the roots or subterranean stems, such as the potato, are commonly innocent, if not wholesome, when boiled; but so formidable are the deleterious properties of the order, that even in the case of the valuable vegetable now under our consideration, the water in which it has been cooked is in a certain degree poisonous.

Starch in considerable quantities is obtained from potatoes, by crushing them, and well washing the pulp repeatedly in cold water till all the starch is extracted; the water then must be evaporated, or decanted off, and the starch will be left nearly pure.—*Saturday Magazine.*

VEGETABLE PRODUCTIONS FURNISHING DRINKS.

TEA may now be fairly regarded as constituting a large portion of the drink of all classes in this country, and is become nearly an absolute necessary—a degree of importance it has attained from its valuable and pleasant qualities. It is a stimulant to the body and mind, without any pernicious reaction, and unproductive of any of those diseases which accompany the use of other stimulants, as spirits, wine, beer, &c.

Green tea possesses the qualities of the plant in a higher degree than the black, to those who are not habituated to its use; it acts as a stimulant to the mental faculties more powerfully than any fermented liquor, and completely banishes sleep for many hours: it is hence the resource of all, who want to watch or study during the hours usually devoted to rest.

The tea-plant is of the same natural order as the camelia of our green-houses, and some species of the tea plant belong to that genus itself; but the best tea consists of the leaves of one species of the genus Thea. This is an evergreen shrub, from three to six feet in height with long, notched alternate leaves, and bears a white-blossom something like a wild rose. It is a native of China and Japan and will grow as far north as the forty-fifth or forty-sixth degree of latitude.

The different teas of commerce are produced from *varieties* only of the one species, but the principal cause of the different flavour is the nature of the soil and situation in which the plant is cultivated, the time of the year in which the leaf is gathered, and the mode of preparing the crop for market.

The cultivation of the tea is nearly confined to a part only of China, for, like the vine, the excellence of the plants depends on unknown peculiarities of soil and culture, which confine it within much narrower limits than its botanical or natural situation. There are two principal kinds of tea, *black* and *green*, of each of which there are several varieties; the former are entirely cultivated in one province, Tokien, to the nort-east of Canton, the most populous and important part of the empire. *Pekoe*, the finest of the black teas, consists of the leaf-buds of the best plants gathered early in spring; a small quantity of the blossoms of an olive are mixed with it to impart fragrance and flavour. The inferior sorts consist of the fully-formed leaves of the same plants: the later in the season these are gathered the less the flavour of the tea; there are three or four successive crops taken in the year. The qualities of the green teas depend on the same circumstances. *Gunpowder*, the finest, consists of the unopened leaf-buds of the green variety of the Thea, gathered before it opens; the inferior qualities being the produce of the subsequent successive gatherings. The leaves of the black teas are picked by hand, and dried under a shed; the different qualities are then sorted, mingled, or separated according to the demand, and after a second and more complete drying, are packed for exportation. The green tea-leaves are dried in iron pans over a stove, and are stirred by *the hand* during the process.

Coffee.—This plant was originally indigenous in Arabia and the countries bordering on the Red Sea, but it has been for a long period successfully cultivated in most tropical countries. It belongs to the extensive natural order furnishing the genuine Peruvian bark, Ipecacuanha, and other valuable medicines. The coffee plant is a small evergreen tree, attaining a height of from twelve to fifteen feet, not much branching, having opposite oval leaves, like the bay tree, and small cream-coloured blossoms, which produce a red berry containing two seeds, flat on one side, which sides are applied to each other as the seeds lie on the fruit. It is these seeds which are used; they are roasted in iron (or now often in silver) cylinders, kept turning round to prevent the contents from being burnt. When roasted, the seeds are ground fine in small mills, the construction of which is familiar to every one; the powder is infused in boiling water, and drunk with or without milk and sugar. That some nicety is requisite in preparing this drink is indisputable, however simple a process it may appear, but the general cause of failure arises from the berry not having been roasted only just before it is wanted, for if kept some time before it is used, a great deal of the aroma escapes, and the flavour is lost.

Chocolate.—The cacas seeds, from which chocolate is prepared, are produced by the *cacao*, a plant of South America; it grows to the height of twenty feet, and bears large oblong leaves and small red blossoms, which are succeeded by a thick scarlet or yellow capsule, seven or eight inches long, containing many seeds as big as a scarlet bean, embedded in a fleshy substance. These seeds are roasted, and the skin being taken off, they are pounded with water, and rolled and beaten on a smooth surface into a plate, which is sweetened, and flavoured with vanilla, cinnamon, &c., and then made up into cakes in iron moulds; when dry and hard, the cakes are put into lead-paper cases to keep them from the air.

Cacao contains a great deal of nutritive matter in a small compass, and is hence of great service to travellers. The only matter which is contained in the seeds is extracted and used as medicine under the name of "*Butter of Cacao.*"—*Saturday Magazine.*

SCENE FROM "KING RICHARD III."

CLARENCE. BRAKENBURY.

Brakenbury. Why looks your grace so heavily to-day?
Clarence. O, I have pass'd a miserable night,
So full of fearful dreams, of ugly sights,
That, as I am a Christian faithful man,
I would not spend another such a night,
Though 't were to buy a world of happy days;
So full of dismal terror was the time.

Brak. What was your dream my lord? I pray you
tell me.
Clar. Methought that I had broken from the Tower,
And was embark'd to cross to Burgundy;
And in my company my brother Gloster:
Who from my cabin tempted me to walk
Upon the hatches; there we look'd toward England,
And cited up a thousand heavy times,
During the wars of York and Lancaster,
That had befall'n us. As we pac'd along
Upon the giddy footing of the hatches,
Methought that Gloster stumbled; and, in falling,
Struck me, that thought to stay him, overboard,
Into the tumbling billows of the main.
O Lord! methought what pain it was to drown!
What dreadful noise of water in mine ears!
What sights of ugly death within mine eyes!
Methought I saw a thousand fearful wrecks:
A thousand men that fishes gnaw'd upon;
Wedges of gold, great anchors, heaps of pearl,
Inestimable stones, unvalued jewels,
All scatter'd in the bottom of the sea.
Some lay in dead men's skulls; and in those holes
Where eyes did once inhabit there were crept,
As 't were in scorn of eyes, reflecting gems,
That woo'd the slimy bottom of the deep,
And mock'd the dead bones that lay scatter'd by.
Brak. Had you such leisure in the time of death
To gaze upon these secrets of the deep?
Clar. Methought I had; and often did I strive
To yield the ghost: but still the envious flood
Kept in my soul, and would not let it forth
To find the empty, vast, and wand'ring air;
But smother'd it within my panting bulk,
Which almost burst to belch it in the sea.
Brack. Awak'd you not with this sore agony?
Clar. No, no, my dream was lengthen'd after life;
O, then began the tempest to my soul!
I pass'd, methought, the melancholy flood
With that sour ferryman which poets write of,

Unto the kingdom of perpetual night.
The first that there did greet my stranger soul,
Was my great father-in-law, renowned Warwick;
Who spake aloud,—"What scourge for perjury
Can this dark Monarchy afford false Clarence?"
And so he vanish'd: Then came wandering by
A shadow like an angel, with bright hair
Dabbled in blood; and he shriek'd out aloud,—
"Clarence is come,—false, fleeting, perjur'd Clarence,—
That stabb'd me in the field by Tewkesbury;—
Seize on him, furies, take him unto torment!"
With that, methought, a legion of foul fiends
Environ'd me, and howled in mine ears
Such hideous cries, that with the very noise
I trembling wak'd, and, for a season after,
Could not believe but that I was in hell;
Such terrible impression made my dream.

—*Shakespeare.*

SOAP.

This very useful article is produced by a combination of tallow or oil with soda or potash; with soda, hard soap is formed; with potash, soft soap. The yellow soap of commerce has also an addition of resin or turpentine, and often palm oil; these give it its yellow colour and peculiar smell; pure white soap is made by boiling a solution of soda with tallow or olive oil. Ordinary soaps are generally made by mixing a solution of the soda of commerce (carbonate of soda) with quick lime. This takes away the carbonic acid and makes the soda what is called "caustic;" this solution is drawn off, and kitchen stuff, tallow, turpentine, and sometimes palm oil, are added and boiled together, until all is converted into soap, but a large quantity of water remaining, it is necessary to separate the soap from this. For this purpose salt is added until the water becomes so heavy that the soap rises to the surface, whence it is removed into moulds or frames and allowed to cool, when it is cut into bars for sale.

Soft soap is made in the same way, using potash instead of soda, and, generally, a large quantity of train-oil. Castile soap is pure soda soap, and the bluish or red mottled appearance is produced by stirring in some sulphate of iron (green vitriol); when new, it is of a bluish colour, but gets red by exposure to the air.

Oils and fats combine with the oxides of several of the metals, and these compounds are all soaps, but by far the greater number of these are useless as such, being quite insoluble in water. A combination of oxide of lead with olive oil forms a firm solid substance, known as lead plaster, which, with the addition of a little resin, is used in surgery, and, when spread upon linen or calico, forms the common adhesive plaster.

Oils and fats all consist of a combination of organic acids with glycerine. When these fats are boiled with soda, potash, or metallic oxides, a combination of the oxide and fatty acid takes place, forming in the ordinary soap, stearate, oleate, and margarate of soda—these constitute soap. The glycerine is set free, and, when purified, forms a sweet, oily, colourless fluid, very similar to syrup, but not so sweet; it has lately been used for several purposes, especially as a remedy for "chapped hands:" a soap called "glycerine soap" has lately been used for the same purpose; it is made without separating the glycerine. Fancy soaps are made from good yellow soap, coloured and scented. White Windsor soap is a pure kind of soap made of tallow and soda; the brown Windsor soap is coloured to imitate old soap, for soap when recent is very soft, and contains much water, it is, therefore, found much more economical to keep it till it gets quite hard from the loss of water; this, however, produces a brownish colour. The history of "Old Brown Windsor Soap" is, therefore, similar to that of brown brandy—both being colourless when new, and both being coloured to imitate age, and carried to such a ridiculous extent, that they become totally unlike the articles they are intended to imitate.

Before the process for making soda from sea-salt was in general use, barilla was the substance employed to make hard soap with. It was an impure kind of soda procured by burning sea-weed, and contained a certain proportion of iron, and in the ley which was made by adding lime there was a dark-coloured sediment; this on being stirred up with the soap produced a dark mottled appearance, and gave rise to the term Mottled Soap.

Since the introduction of soda, it also has to be imitated to keep up an article of a well-known quality.

Soap is quite soluble in spirit and also in warm distilled water, but in ordinary water it is to a great extent insoluble, producing a milky solution; this is owing to the lime contained in the water which forms an insoluble soap; soap has therefore been used as a test of the hardness of water. A solution of soap in spirit being dropped into a specimen of the water, the amount of sediment shews its hardness.—*Boys' Book of Industrial Information.*

LEATHER.

TANNING is the name given to the process for converting the skins of animals into leather, by combining them with a substance called "Tannin." This exists in many vegetable substances, such as oak-bark, gall-nuts, sumach, &c., &c.; all of these, and many more, are used for tanning, but, on account of its cheapness, oak-bark is the usual substance employed.

It is tannin which gives the quality of astringency to many vegetables, and this very taste of astringency is produced by a partial contact of the tannin with the surface of the mouth.

The skins (called "hides" or "pelts") are first freed from all loose pieces of flesh, fat, or skin; the hair is then removed by soaking them in lime and water. The skins are next laid in the "tanpit," between layers of crushed oak-bark, until the pit is nearly full; water is then pumped in, and the whole is allowed to remain for several weeks or months (according to the thickness of the skin), during which time, however, the skins are changed in position, by removing them from one pit to another with fresh bark in it, so that those taken from the top of the first, are placed at the bottom of the next; and this is done from time to time, in order that all may receive the same pressure and strength of tan-liquor. Very thick bodies take a year to tan perfectly in this way, and consequently many processes have been tried to quicken the operation; but the leather made most slowly seems to wear the best, and consequently fetches a higher price.

Skins which are thin, and to be used for fancy-work, as for book-binding and glove-making, are either tanned with "sumach," or with alum and salt made into a paste with flour and yolk of eggs; this is put into a tub, and the mixture and skins worked together till they are thoroughly united.

Besides boots and shoes, leather is used for the harness of horses, covers for seats, gloves, and innumerable other articles.

For some uses the leather is required to be very thin, and of exactly one thickness. This is obtained by the process of splitting, for which a machine is used whose exactness is such, that one slice is taken from the inner part of the skin without cutting a hole in any part. The skin is stretched tightly round a roller, which slowly revolves against a straight knife-edge, fixed at a certain distance from it, according to the thickness of the skin, and which is passed by the machine backwards and forwards, cutting the skin a little further each time.—*Boys' Book of Industrial Information.*

PAPER.

THIS important article of civilization is made from rags, and other fibrous materials, according to the kind of paper required, the finest and thinnest white paper (such as bank-notes and foreign writing paper) being made of old clean linen rags; thicker paper, of linen and cotton rags; newspapers, of coarse linen, white rope, Esparto grass, palm, and the ground fibre of the aspen and poplar, while brown paper is made of all sorts of rope-yarns, or sacking, and some kinds have a considerable amount of straw bleached and worked up in them, largely mixed with gypsum, clay, and ochre, to give weight and colour. The rags are first sorted and cut up into small pieces; they are then placed on a revolving screen to separate all dust; after which they are put into cylindrical or spherical boilers, where, mixed with lime and soda, and constantly agitated, they are boiled by steam at high pressure for many hours, until all grease and dirt are entirely dissolved. They are next put into the washing-machine (through which a stream of water runs) where they are torn by a heavy roller, having iron knives fastened to its edge or surface, which work, as the machinery is turned, against knives of a similar description fastened to the bottom of the cistern. When the rags are thoroughly washed, and at the same time torn to a coarse pulp, they constitute what the workmen call "half-stuff." This is mixed with chloride of lime (the machine being again set in motion) for the purpose of bleaching the pulp, in which solution it remains until it is quite colourless. The pulp is now either put into another machine of the same description, which cuts sharper and finer; or else the same machine, used at first, is so screwed up as to cause the knives to come more closely together; in either case, the rate of turning is greatly increased, so that the wheel makes about 150 revolutions per minute, and completely grinds up the pulp till it is perfectly smooth. At this part of the process various colours are mixed with the pulp, such as ultramarine, chrome, and the "aniline dyes." These are seen in blue "foolscap," "cream-laid," "toned," and other varieties.

Paper is now nearly all made by machinery, in pieces of any width up to 120 inches, but of an indefinite length, and is afterwards cut up into sheets by a "cutting machine." The paper-making machine consists of a reservoir for the fine pulp, prepared as before described, and fitted with regulating valves for limiting the flow of "stuff." This, largely diluted with water, passes through finely-cut strainers, which stop all knots and portions badly prepared, and it is then delivered to an endless revolving sheet of wire-gauze, with from 3,000 to 5,000 perforations in each square inch—so fine that, although by the aid of a shaking arrangement the water gradually passes through, the fibres are retained on the upper surface, and by the constant agitation and the "felting" quality possessed by the beautifully serrated edges of the fibres, the fluid sheet of pulp is in a few seconds so strong, that it can be carried with but little assistance to the subsequent stages.

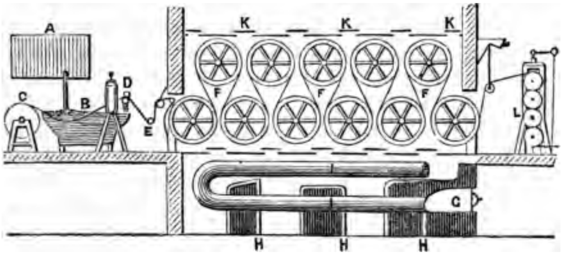
Leaving the wire-cloth, the sheet is carried by a travelling blanket, between heavy, smooth, rollers (which give solidity and remove more moisture), and then over a number of cylinders, heated by steam, and so arranged that the process of drying may take place as gradually and uniformly as possible. The glazing, between hot and very highly polished rollers, completes the process; after which it is reeled in lengths of a mile or more, as may be convenient, and cut into sheets by the cutting apparatus, in which, as it passes through, it is cut by rippers lengthwise to any width required,and by a nice adjustment a knife, which crosses the machine and which can be regulated precisely to the length of sheet wanted, is made to come down and cut the paper across. The sheets thus formed are arranged evenly in piles as they leave the cutter,from whence they are carried to be examined and put up in quires and reams for the market.

The required width of the sheet is given by means of an adjustable strap or "deckle," and the rapid drying is greatly facilitated by boxes with perforated tops, fixed under the travelling wire-cloth. In these a partial vacuum is made by powerful air-pumps, and the pressure of the atmosphere forces the water through the wire into the boxes, leaving the pulp comparatively dry.

Water-marks, such as names, dates, figures, &c., are given in this damp state by means of a light wire-covered roller, called "a dandy." The required pattern is worked on its surface with brass wire, which, penetrating partly through the moist pulp, leaves its impress at each revolution.

The same "dandy," according to the way in which it is covered, makes the difference between "laid" and "wove" papers; the former is produced by a covering of parallel wires, fastened at intervals of an inch or so; the latter, by a cover of similar character to the wire-cloth on which the pulp travels. The "laid" appearance is well seen in ordinary foolscap.

The sizing makes the difference between blotting-paper and that used for writing or printing. In ordinary printing paper it consists of a resinous soap, and is added to "the stuff" in the beating engine. In the higher qualities a thin glue is used, and this is invariably done at the "paper-making machine," and the requisite machinery is shewn in the accompanying fig. A, is a reservoir for size; B, a trough for the papers to dip into; C, the reel of paper to be sized; D, rollers to press out all super-



Sizing Machine.

fluous size; E, a pulley to keep the paper on the stretch; F F F, a succession of hollow "drums" to prolong the passage of paper through the air of the drying-room, which is heated by the furnace G and the tubes I I; H H are openings to admit fresh air, and K, openings to allow the exit of the steam from the paper as it dries; L, is a series of rollers to glaze it.

But the process as conducted by hand will give a much better notion of how paper is formed from the pulp. A reservoir is filled with pulp (which is supplied by a wheel in the box to a strainer) and passed to a vat; a man takes in his hands a mould, consisting of a shallow frame of wood of the size the sheet of paper is to be, having a bottom of fine wires laid side by side, and also crossing at intervals, to keep them firm (the marks of these wires may be seen in any sheet of laid foolscap paper held up to the light); he dips this mould edgewise into the reservoir, and brings it up horizontally full of pulp; this he gently shakes, to make the pulp lie level and allow all superfluous water to drain through the wires. It is then handed to another man, who has a sheet of flannel or felt spread out on a table, on which the mould is inverted, and the sheet of pulp left on the flannel, which sucks up more of its moisture. Over this is placed another piece of flannel, and then another sheet of pulp on it, and so on to the number of five or six dozen; then the whole is put into a powerful press, and screwed down till all the water is squeezed out. When they are pretty firm, they are lifted out and hung on lines to dry; after which they are immersed in a cistern filled with thin size, made by boiling clippings of skin in water, and having some alum dissolved in it, and are once more pressed and dried. What is called "hot-pressed" paper is pressed between smooth sheets of pasteboard, having a hot-iron plate placed between every three or four dozen sheets; this gives it a a smooth surface. The names, dates, and other marks seen on hand-made paper, bank-notes, &c., are formed by wires worked into the bottom of the mould, which, projecting, make the pulp thinner in those places.

LOOKING GLASSES.

THE mirrors of ancient times were formed of polished metal, those of the Jewish women, as we learn from Scripture, were of brass. It is doubtful at what time, and by whom the covering of mirrors of glass with quicksilver and tin was first accomplished; like other inventions, probably, this was discovered by several artists, perhaps, at the same time, and independently of each other. The manner in which the manufacture is at present carried on is as follows:—A slab of stone of any requisite size is ground perfectly level and smooth; this slab is surrounded by a frame-work of wood, which rises several inches above it; but the slab itself is so fixed that its surface is raised from the back of the frame, so as to leave a kind of groove, or gutter, all round, between the stone and the wood.

The slab, with its frame-work, is mounted so as to form a table, but so adjusted by means of screws that it can at any time have its surface thrown into an oblique position. The table being thus prepared, its surface is covered with tin-foil, and mercury being poured over it, a hare's foot is used to spread it over the surface of the tin and cause it to amalgamate with the latter metal; more quicksilver is then poured on it, until the surface is covered to the depth of nearly a quarter of an inch. The plate, or plates of glass (for it is not necessary that the table should be occupied by one plate alone), are rendered perfectly clean, and a piece of smooth paper is laid over the edge of the frame nearest the workman, dipping into the mercury. The workman holds this paper in his right hand, and taking the clean glass in his left, lays it flat upon the paper and slides it gently into the mercury, causing the edge to dip just below its surface. When the whole of the plate has passed on to the mercury, it is gently floated to the farthest end of the frame; another plate is treated in the same way, until the table is wholly covered. Leaden weights covered with green baize, and each weighing seven pounds, are then placed upon the glass nearly close to each other; these are allowed to remain on from twenty-four to thirty-six hours; they are then removed, and the table being gently raised by means of the adjusting screws, the superfluous mercury flows along the gutter towards the lowest corner, at which place there is a hole, furnished with a plug, through which it is drawn off to be used on another occasion. The plates of glass are left for a few hours more to drain, and then, being lifted off the table, are placed on a shelf resting against the wall, to get rid of the fluid mercury that still remains; this shelf is also provided with an inclined gutter to carry off the liquid metal.

The loose weights used in this mode of silvering are considered by some manufacturers to be dangerous, as they are likely, at times, to slip out of the workman's hand by accident; to obviate this danger an apparatus has been invented, in which a steady pressure, by means of screws, is substituted in the place of that produced by the weights.

In silvering the commoner kinds of looking-glass the plate is lifted from the table the instant it has the tin-foil attached, and set on its end to drain, without sustaining any previous pressure. Concave and convex glasses are silvered on models made to fit them exactly. In silvering globes of glass, a metallic amalgam is prepared and poured into the globe, which is moved about in all directions until the amalgam has attached itself to the surface of the glass: this succeeds best when the glass is made hot.

KING HENRY V.

HENRY the Fifth (who, at the beginning of his reign, made a public prayer in the presence of his Lords and Commons, that he might be cut off by an immediate death, if Providence foresaw he would not prove a just and good governor, and promote the welfare of his people), manifestly derived his courage from his piety, and was scrupulously careful not to ascribe the success of it to himself. When he came within sight of that prodigious army, which offered him battle at Agincourt, he ordered all his cavalry to dismount, and, with the rest of his forces, to implore upon their knees a blessing on their undertaking. In a noble speech, which he made to his followers immediately before the first onset, he took notice of a very remarkable circumstance, namely, that this very day of battle was the day appointed in his own kingdom to offer up public devotions for the prosperity of his arms, and therefore bid them not doubt of victory, since at the same time that they were fighting in the field, all the people of England were lifting up their hands to heaven for their success. Upon the close of that memorable day, in which the king had performed wonders with his own hand, he ordered the 115th psalm to be repeated in the midst of his victorious army, and at the words, "Not unto us, not unto us, but unto Thy name be the praise," he himself, with his whole host, fell to the earth upon their faces, ascribing to Omnipotence the whole glory of so great an action.

KING HENRY THE FIFTH.

CHORUS.

THE poor condemned English,
Like sacrifices, by their watchful fires
Sit patiently, and inly ruminate
The morning's danger; and their gestures sad,
Investing lank-lean cheeks, and war-worn coats,
Presenteth them unto the gazing moon
So many horrid ghosts.
Oh, now, who will behold
The royal captain of this ruin'd band
Walking from watch to watch, from tent to tent,
Let him cry—Praise and glory on his head!
For forth he goes and visits all his host;
Bids them "Good-morrow" with a modest smile,
And calls them—brothers, friends, and countrymen.
Upon his royal face there is no note

How dread an army hath enrounded him;
Nor doth he dedicate one jot of colour
Unto the weary and all watched night;
But freshly looks, and overbears attaint,
With cheerful semblance and sweet majesty;
That every wretch, pining and pale before,
Beholding him, plucks comfort from his looks;
Then, mean and gentle all,
Behold, as may unworthiness define
A little touch of Harry in the night:
And so our scene must to the battle fly;
The field of Agincourt.
K. Henry. Upon the king! let us our lives, our souls,
Our sins, lay on the king!—we must bear all.
Oh hard condition, twin-born with greatness,
Subjected to the breath of every fool.
What infinite hearts' ease must kings neglect
That private men enjoy!
And what have kings, that privates have not too
Save ceremony, save general ceremony?
And what art thou, thou idle ceremony?
Art thou aught else but place, degree, and form
Creating awe and fear in other men?
Wherein thou art less happy being fear'd
Than they in fearing.
What drink'st thou oft, instead of homage sweet,
But poison'd flattery? Oh, be sick, great greatness,
And bid thy ceremony give thee cure!
Canst thou, when thou command'st the beggar's knee,
Command the health of it? No, thou proud dream,
That play'st so subtly with a king's repose:
I am a king that find thee; and I know,
'Tis not the balm, the sceptre, and the ball,
The sword, the mace, the crown imperial,
The throne he sits on, nor the tide of pomp
That beats upon the high shore of this world.
No, not all these, thrice-gorgeous ceremony,
Not all these, laid in bed majestical,
Can sleep so soundly as the wretched slave,
Who, with a body fill'd and vacant mind,

Gets him to rest cramm'd with distressful bread;
And but for ceremony, such a wretch,
Winding up days with toil and nights with sleep,
Had the fore-hand and vantage of a king.

Enter Erpingham.

Erp. My lord, your nobles, jealous of your absence,
Seek through your camp to find you.
K. Henry. Good old knight,
Collect them all together at my tent:
I'll be before thee. [*Gives back the cloak to Erpingham.*
Erp. I shall do it, my lord. [*Exit.*
K. Henry (*kneeling*). O God of battles! steel my soldier's hearts;
Possess them not with fear; take from them now
The sense of reckoning, lest the opposed numbers
Pluck their hearts from them!—Not to-day, O Lord,
Oh, not to-day, think not upon the fault
My father made in compassing the crown!
I Richard's body have interred anew,
And on it have bestowed more contrite tears,
Than from it issued forced drops of blood:
Five hundred poor I have in yearly pay,
Who twice a day their withered hands hold up
Toward heaven, to pardon blood:
More will I do.— [*Trumpet sounds without.*
Henry (*starting to his feet*). The day, my friends, and all things stay for me. [*Ex*
—*Shakespeare.*

GOLD-LEAF BEATING.

The extraordinary malleable nature of gold, which appears to have been known from the remotest antiquity, together with its power of resisting the action of the atmosphere and of acids, have brought this valuable metal into more common use than its extreme rarity would otherwise permit. To render it available for the purpose of covering various substances, it is beaten into very thin leaves. The art of the goldbeater requires very great practice, and considerable manual dexterity, and in all its operations the greatest care is necessary to ensure the uniform thickness of the leaf when it is finished.

The gold, which must be perfectly pure, is first cast into small bars, each weighing two ounces, of about three-quarters of an inch in width. The first operation is to extend the bars of gold in length, and to reduce them in thickness. The process of rolling hardens the gold, and to restore its malleability, it is frequently heated to redness. The operation of rolling is continued until the riband of gold is so much reduced in thickness, that a square inch will weigh about six grains and a-half. The first act of the goldbeater is to cut these ribands into pieces about an inch square.

About 150 of these square pieces of gold are placed between as many of vellum about four inches square; the gold is placed as nearly as possible in the centre of each leaf, and about twenty extra pieces of vellum are placed at the top and bottom of the pile. The whole packet of leaves and gold are then strapped together to keep each in its place in the manner shewn in the engraving. Fig. 1 is a band of strong parchment, into which, as shewn in fig. 2, the packet of leaves is forced; this band or belt thus confines them in one direction; the packet thus partially confined is then forced into another strap of the same description, which crosses the first at right angles, and completes the confinement of the leaves.

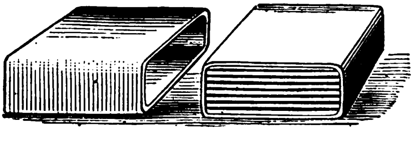


Fig. 1. Fig. 2.

The reduction of the gold squares in thickness is then effected by means of a hammer with rather a rounded face, about four inches in diameter, weighing from fifteen to sixteen pounds, and fixed to a short handle. The beating is performed on a block of black marble, or other hard stone about nine inches square and of considerable weight, the heavier the better; this marble block is embedded in a framework of wood about two feet square, its upper surface level with the top of the stone. Round three sides of this wooden frame a narrow ledge is raised, while the fourth side, opposite which the workman sits, is furnished with a leather apron, which the goldbeater places round him when at work, for the purpose of receiving any pieces of gold that may escape from the packet. The workman strikes fairly upon the middle of the packet, which he frequently turns over to beat the opposite side, but this he does in the interval between two strokes, without losing his blow. He keeps up a constant beating, and when fatigued with one hand, he dexterously changes the hammer to the other whilst it is elevated in the air, and without any loss of time or force. The packet is every now and then bent, and rolled between the hands of the workman, to give more freedom to the gold as it extends; and it is several times during the operation opened to see how the work proceeds, and to shift the leaves which were in the centre to the outside of the packet. The beating is continued until the gold squares are nearly the size of the skins of vellum between which they are placed.

They are then taken out, and each square is cut into four pieces by drawing a knife across it in two directions. These squares are again made up into packets, but instead of being placed between vellum, as in the first instance, a substance called goldbeater's skin is employed, which is prepared from the intestines of an ox, made into pieces about four inches square. A smaller hammer is now used, and the beating is continued, the packet being more frequently rolled in the workman's hands, on account of the thin state to which the gold is now reduced. When the gold leaves by this second beating have reached the size of the goldbeater's skin, they are again cut into four, and again subjected to the power of the hammer: by this means they are extended to 192 times their original surface, each ounce of gold thus covering the space of 100 square feet: but this is not by any means so thin as they may be made, for it is very practicable to extend an ounce to 160 square feet. The gold leaves are now cut exactly square by means of a small tool formed of two narrow strips of ivory fixed in a frame at a distance from each other equal to the width of the leaf, being lifted from the cushion on which they are cut by means of a pair of tweezers, fig. 3. They are then made up into books, each containing twenty-four leaves of gold; the books of thin paper are rubbed over with red chalk, to prevent the gold adhering.—*Saturday Magazine.*

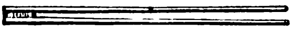


Fig. 3.

SCENE FROM "THE LADY OF LYONS."

MELNOTTE. PAULINE.

Mel. Pauline, by pride
Angels have fallen ere thy time: by pride—
That sole alloy of thy most lovely mould—
The evil spirit of a bitter love,
And a revengeful heart, had power upon thee.
From my first years my soul was filled with thee:
I saw thee midst the flow'rs the lowly boy
Tended, unmarked by thee—a spirit of bloom,
And joy, and freshness, as if spring itself
Were made a living thing, and wore thy shape!
I saw thee, and the passionate heart of man
Entered the breast of the wild, dreaming boy,
And from that hour I grew—what to the last

I shall be—thine adorer! Well, this love,
Vain, frantic, guilty, if thou wilt, became
A fountain of ambition and bright hope;
I thought of tales, that by the winter hearth
Old gossips tell—how maidens sprung from kings
Have stooped from their high sphere; how Love, like
Death,
Levels all ranks, and lays the shepherd's crook
Beside the sceptre. Thus I made my home
In the soft palace of a fairy Future!
My father died; and I, the peasant-born,
Was my own lord. Then did I seek to rise
Out of the prison of my mean estate;
And, with such jewels as the exploring Mind
Brings from the caves of Knowledge, buy my ransom
From those twin gaolers of the daring heart—
Low Birth and iron Fortune. Thy bright image,
Glassed in my soul, took all the hues of glory,
And lured me on to those inspiring toils
By which man masters men! For thee I grew
A midnight student o'er the dreams of sages!
For thee I sought to borrow from each Grace,
And every Muse, such attributes as lend
Ideal charms to Love. I thought of thee,
And Passion taught me poesy—of thee,
And on the painter's canvas grew the life
Of beauty! Art become the shadow
Of the dear starlight of thy haunting eyes!
Men called me vain—some mad—I heeded not;
But still toil'd on—hoped on—for it was sweet,
If not to win, to feel more worthy thee!
Pau. Has he a magic to exorcise hate?
Mel. At last, in one mad hour, I dared to pour
The thoughts that burst their channels into song,
And sent them to thee—such a tribute, lady,
As beauty rarely scorns, even from the meanest.
The name—appended by the burning heart
That long'd to shew its idol what bright things
It had created—yea, the enthusiast's name,
That should have been thy triumph, was thy scorn!

That very hour—when passion, turned to wrath,
Resembled hatred most—when thy disdain
Made my whole soul a chaos—in that hour
The Tempters found me a revengeful tool
For their revenge! Thou hadst trampled on the worm—
It turn'd and stung thee!

Lord Lytton.

ON INK.

When a material, such as paper or parchment, had been discovered, which by moderate care might be preserved through a course of ages, it evidenly became an important object to employ an equally permanent and durable substance, wherewith to describe those characters which should reveal to future generations the thoughts and proceedings of the men of other days. It were evidently of little use to have attained the one without securing the other also. If the paper be permanent, so also must be the ink; which latter condition, as far as manuscripts are concerned, has ever been of difficult attainment; nor are we sure that our best writing inks of the present day, are calculated to resist successfully the action of time.

The ink of the ancients seems to have been of a viscid, or oily nature. Unlike the modern writing ink, it consisted of nothing more than colouring matter and gum. The chief ingredient was a species of soot, or ivory-black, mixed with one-fourth of gum. This mixture was formed into cakes or rolls, with the addition of a little water, and dried in the sun. A similar mode is practised at the present day by the Chinese, in their celebrated Indian ink, which consists of nothing more than minutely divided carbon mixed with gum-water, and cast in a mould. This was the ink of the age of Pliny, and continued in use until the 7th century. It was, probably, prepared for writing in a manner similar to the preparation of our water-colours for painting;

but it was made more sticky, for the letters in ancient manuscripts frequently appear in relief. Dr. Bancroft thus speaks of the writing-ink of Pliny, who lived in the 1st century of the Christian era. Any person who will take the trouble of mixing pure lamp-black with water, thickened a little by gum, may obtain an ink of no despicable quality in other respects, and with the advantage of being much less liable to decay by age than the ink now in common use.

We must remark, however, that every black pigment mixed with gum or size, can be readily washed off the paper with water; and Pliny seems to have been aware of the fact, that unless inks sink into the surface of the papyrus, parchment, &c., they can be removed by washing. To obviate this defect, it was common in his age to use vinegar instead of water, for tempering the mixture of lamp-black and gum. An unstable sort of ink was used by Moses among the Jews in certain ceremonials described in the law; and, in fact, eastern inks, at the present day, may be easily obliterated with a wet sponge. Mention is also made of Golden Ink in use among various nations, and amongst others by the Anglo-Saxons. Silver ink was also not uncommon. Red ink was made of vermilion cinnabar. Purple ink is very often found in manuscripts, but none were written entirely with ink of that colour. Capital letters were often written with an ink composed of vermilion and gum. Green ink was rarely used in charters, but often in Latin manuscripts, especially those of the later ages. The guardians of the Greek emperors employed green ink for writing the signatures of the princes until the latter came of age. Blue and yellow inks are sometimes found. Yellow ink has probably not been in use these 600 years. In some manuscripts metallic and other characters are varnished. Wax was used as a varnish by the Latins and Greeks, but more by the latter. This covering, or varnish, is common in writings of the ninth century.

The word Sepia (or the *cuttle-fish*), is used by some Latin authors for ink, because this fish, when afraid of being caught, discharges a black matter, in order to conceal itself, which the Romans sometimes used for ink.

Of the various specimens of black ink, with which we meet in ancient writings, that used by the Anglo-Saxons, in the 8th and two following centuries, preserves its original blackness much better than that of succeeding ages, (not even excepting the 16th and 17th centuries,) in which it was frequently very bad. Pale and decayed ink rarely occurs at any time previous to the last four centuries. Du Cange says, that the emperors of the east wrote with red ink, preserved in a golden ink-horn, set with gems. He also mentions a black or dark-coloured ink, made of silver and lead, by which the cavities in sculpture were marked.

We now come to speak of modern ink, which may be considered under the following heads:—*1st,* Indian Ink; *2nd,* Printers' Ink; *3rd,* Writing Inks; *4th,* Sympathetic Inks, including Marking Ink. In the first three varieties, only black, red, and blue are known of in common use, but some printers employ ink of various colours.

1st.—Indian Ink, or more properly China Ink, is used in China for writing with a brush, and for painting upon the soft flexible paper of Chinese manufacture. The manufacture of China ink was long kept secret, but there now is no doubt of its composition. Lamp-black and size, or animal glue, or gum, are the necessary ingredients, although perfumes and other substances, not essential to its quality as an ink, are sometimes added. The fine soot from the flame of a lamp or candle, collected upon a cold plate held over the flame, and mixed with pure size made from clean parchment, will afford an ink equal to any that is imported.

2nd.—The making of printers' ink is a distinct branch of trade in itself. The printers' ink-maker is not a printer, nor does he make any one of the varieties of writing ink.

Printers' ink may be called a black paint. It is smooth and uniform in its composition, of a firm black colour, and is remarkable for the singular facility with which it adheres to paper, that is thoroughly moistened. Hence it is that the printer always wets the sheets before printing; and the reader will have no difficulty in calling to mind instances of wet newspapers, damp books, pamphlets, &c., dampness being always associated with the freshest wares of the publisher.

Printers' ink consists chiefly of varnish, made from linseed or resin oil (boiled together with black resin) and lamp-black. Prussian blue is generally added to improve the colour; sometimes, for the same purpose, a little red lead, or Chinese red is put into it.

It is prepared in the following manner. A given quantity of varnish is poured into a round iron pot, in the centre of which is an upright shaft, fitted with long blades, which is made to revolve by steam power, so that the blades, which stick out of it to some distance, cut and mix up the contents of the pot. After a short time, when the knives have sufficiently cut the varnish, lamp-black and other materials (as Prussian blue, &c.) are added to it, and the mixing is continued, till the whole has been reduced to a paste. It is then taken from the mixing pot, and well ground between iron rollers, after which process it is ready for the printer.

The ink used for newspapers is much thinner and cheaper than that which is employed in printing the best books: for stiff ink could not be distributed over large forms of type at the speed required by modern newspaper presses.

Coloured printing inks are made by mixing fine linseed oil varnish with different pigments, according to the colour wanted.

3rd.—Writing Ink.—All the black inks commonly used are formed by mixing sulphate of iron, more generally known as green vitriol, with some vegetable matter, such as nut-galls, or logwood, which is a cheaper material, and adding boiling water. It may be easily made by putting one pound of bruised galls and half a pound of green vitriol into a stone bottle or jar holding a gallon, and then filling it up with rain-water, occasionally stirring the mixture, till the colouring matter has been well extracted from the galls. By the addition of half a pound of gum a very good copying-ink may be obtained, by which the writing can be transferred by pressing upon it a thin piece of wet tissue paper.

Blue ink may be obtained by dissolving Prussian blue in oxalic acid. Red ink is easily made by taking a few chips of Brazil wood, boiling them in vinegar, and mixing with the solution a little alum and gum.

4th.—Marking Ink, so useful for writing one's name on linen, so that it will neither wash out nor become blotted, when put into water, is made by dissolving nitrate of silver (with which you will often see the fingers of a photographer stained black) in water, and then adding to it some solution of ammonia, a little gum, and Indian ink. This is called sympathetic ink, because when first used it is scarcely visible, but the action of heat brings out its blackness. So, too, there are some acids, which are used for writing upon paper, the writing of which is not capable of being read until held before a fire. These sympathetic inks are now sometimes used for postal cards, so that the communication may not be read, until the receiver has applied heat to the writing; but their use is too troublesome to become general.

For removing black ink-stains from mahogany furniture, the quickest remedy is red ink, laid on the spots with a pen or feather for a few minutes, and then rubbed off with a wet cloth, when the stain will disappear; but, if allowed to remain too long, a red mark will have taken the place of the black one.

A few drops of nitric or muriatic acid, rubbed upon a slate, will clean it both of ink-marks and of grease, but care must be taken not to burn the fingers with it; and the slate must be well washed, as these acids are poisonous. Strong muriatic acid, or spirits of salts, applied to the ink spilt upon the boarded floor of a school-room will remove the unsightly mark, if well washed afterwards with water.—*Rev. J. Ridgway.*

CLEANLINESS OF PLANTS AND ANIMALS.

NEATNESS or cleanliness of creation is one of the most striking provisions in nature, as it is also one which seems to have been nearly overlooked by naturalists, or viewed as if it were confined to a few animals. It will be seen, on the contrary, that it is one of the Creator's leading designs, and that careful provisions have been made for it, both in the animal and vegetable department of life.

The contrivance for this purpose in plants consists in the nature of surfaces, most remarkable in the leaves, where this object is sometimes attained by a high polish and great density, at others by a waxy secretion, at others again, by a minute texture of the surface resembling that of hairs and feathers, or by means of actual down or hairs; as in the flowers the globular velvety surface, which enhances the colours by dispersive reflection, serves for this end also. These prevent the lodgement of water, which is itself injurious, and, with that, of all liquid matters which might soil them; while the dust which might have adhered in a dry state, is easily dislodged by the first shower. How effectual the provisions are is evident; since a dirty plant (to use an expressive term) is scarcely ever seen, peculiarly exposed as they are to the adhesion of soil; and thus does the vegetable world present that universal look of cleanliness and neatness, which is as striking as if there were a hand perpetually employed in no other office; preserving an order, that we cannot maintain in our possession without constant labour.

The same cleanliness, with the same decided intention to produce it, pervades the animal creation, and under many more forms than it is convenient or proper to notice. To man, it has been permitted to do what he pleases; and he is not slow in disobeying the universal command, which the other animals have received through instincts for this purpose, and through provisions for rendering neatness attainable by them: as thus also has he contrived to make some of his followers what he too often is himself. And if we forget to note this also, we should certainly have found it a very difficult problem to devise the means of keeping all this multitudinous world of animals in that state of neatness, in which we find some difficulty to preserve ourselves, peculiarly exposed as they are to soil. Yet a dirty animal, like a dirty plant, is scarcely to be found: the very mole and the earthworm, inhabiting the soil itself, are without a stain; the snail is clean notwithstanding its adhesive surface; the purity of the swan in the midst of the mud is almost proverbial. In the birds, indeed, we see a necessity for neatness, while we find the instincts as strong as the provisions are perfect. But in the terrestrial animals, there is no utility, nor does any inconvenience arise from the reverse; whence we must conclude, that the Creator's intention was simply neatness, order, cleanliness; a virtue to which we are willing to give a place, in words at least, among the minor ones, as we term them.

In these, and in the birds, the essential provision is similar to that in plants, consisting in the structure and superficial texture of hair and feathers. Popular prejudices term these animal substances less cleanly than vegetable ones; the facts are the direct reverse, as common experience in our own clothing should shew. They do not absorb water, and, like plants, they repel the adhesion of what is dry. Thus do the quadrupeds keep themselves clean with very little effort, as the birds do, under that pruning (or picking out superfluous and decayed feathers) in which they have been commanded to delight. In insects the provisions are much more striking. The most naked larvæ are always clean, like the earthworms, inhabit where they may. In others, a peculiar texture of the surface, like that of hair, produces the same effects; and thus we find down, or hair, (as in the bee, the butterfly, and the caterpillars,) preventing all adhesion of the several substances to which they are exposed;

but, as if to satisfy us of the Creator's decided intention on this subject, we find some of these animals provided with the very utensils of cleanliness which we construct for ourselves, furnished with brushes, together with that attached instinct of neatness which we daily see in use in the house-fly; while it would be easy to add much more to the same purpose from the records of natural history.

There is yet more provided for the same end, if in a very different manner, though in these cases, seeing that provision is made for the salubrity of the atmosphere and the waters, and for the feeding of animals, we easily overlook the second, if not secondary purpose. Dead fishes are rendered luminous, that they may be discovered and consumed before they become offensive. On the land, the consumption of carcasses is provided for by the instincts given to several beasts and birds of prey, and, beyond all, by the appointment of the different larvæ, which are destined to this food; while, to make that expedient availing, such is the produce, and such the rapidity of growth, as to have made naturalists remark, that the progeny of three or four flies is sufficient to consume a horse. And assuredly, for the same end, has there been implanted in almost every animal that instinct, through which they seek concealment when about to die; while how effectual this is we know, since with, I believe, the sole exception of the straw mouse, often choosing a gravel-walk for the purpose, we scarcely ever meet the dead body of a wild animal.—*Saturday Magazine.*

MORNING SONG.

Hail! morning sun, thus early bright,
Welcome sweet dawn! thou younger day!
Through the dark woods that fringe the height,
Beams forth, e'en now, thy ray.

Bright on the dew, it sparkles clear,
  Bright on the water's glittering fall,
And life, and joy, and health appear,
  Sweet morning! at thy call.

Now thy fresh breezes lightly spring
  From beds of fragrance, where they lay,
And roving wild on dewy wing,
  Drive slumber far away.

Fantastic dreams, in swift retreat,
  Now from each mind withdraw their spell,
While the young loves delighted meet,
  On Rosa's cheek to dwell.

Speed, zephyr! kiss each opening flower,
  Its fragrant spirit make thine own;
Then wing thy way to Rosa's bower,
  Ere her light sleep is flown.

There, o'er her downy pillow fly,
  Wake the sweet maid to life and day;
Breathe on her balmy lip a sigh,
  And o'er her bosom play;

And whisper, when her eyes unveil,
  That I, since morning's earliest call,
Have sigh'd her name to every gale,
  By the lone waterfall.

Mrs. Hemans.

SILVER.

Masses of native silver have no determinate form, being found sometimes in small branches, occasionally in hair-like threads, and very frequently in leaves; in which form it is usually met with in the mines of Siberia, where it is said never to have been discovered in a state of crystallization. In the Peruvian mines, it is found in a form somewhat resembling fern-leaves; this figure is caused by a number of eight-sided crystals, so placed over each other as to give it a vegetable appearance. It sometimes assumes the form of round, rather crooked threads, varying from the thickness of a finger to that of a hair. It is rarely found in a state of purity, being frequently mixed with gold, mercury, copper, tin, iron, and lead.

Silver is sometimes found in combination with sulphur, arsenic, and other substances: when mineralized by sulphur alone, it forms the vitreous silver ore, which assumes a great variety of colours; when united to sulphur and arsenic, the mass becomes the ruby-like ore, varying in colour from deep red to dark gray in proportion to the prevalence of either of these substances.

Silver is found both in the primitive and secondary earths, and is frequently imbedded in quartz, jasper, hornstone, and chalk. It is chiefly met with in Sweden, Norway, and the polar latitudes; when it occurs in hot climates, it is generally amidst mountains covered with perpetual snows.

The richest and most important silver mines in Europe are those of Königsberg in Norway; they are situated in a mountainous district, and divided into superior and inferior, according to their relative position; the beds in which the silver is found run from north to south. These mines are of considerable depth, and enormous masses of native silver are said to have been found in them.

The French mines are not so remarkable for the richness of their silver-ore as for the other minerals they contain. That of Allemont, ten leagues from Grenoble, is one of the principal; it is situated at the height of nearly 3,000 feet above the level of the sea; the veins near the surface were the richest in silver. This mine is now abandoned.

The most celebrated of the Spanish silver mines is that of Guadalcanal, in Andalusia, situated in the Sierra-

Morena, a few miles to the north-east of the quick-silver mine of Almaden; it was well-known to the Romans, and formerly very productive. This mine furnishes the ruby-ore.

Silver, however, is most abundant in the centre of the Andes; for here we find the celebrated mountain of Potosí; it is of immense height, and said to be penetrated with veins in every direction. When first discovered in 1545, the veins were nearly all of pure silver, latterly, however, little more than five drams were obtained from one hundredweight of ore. In the space of ninety-three years from its discovery, the number of ounces of silver extracted from this mountain is calculated to have been no less than four hundred millions.

Among the American mines those of Mexico must not be forgotten; that of Valenciana, in the district of Guanaxuato, is one of the richest; the vein traverses a slaty mountain, and abounds with silver, both native and mineralized. The mine is of great depth, and is supposed to contain a greater quantity of silver than all the other mines of that country.

Silver possesses all the properties of other perfect metals; it is fixed and unalterable in the fire of any ordinary furnace, but may be volatilized, being sometimes found in the soot of chimneys where large quantities are melted. When exposed to the focus of a large burning-glass, it evaporates in a fume, which rises to the height of five or six inches, and will completely silver a plate of metal.

With the exception of gold, silver is the most ductile of all metals; a single grain may be extended into a plate of one hundred and twenty-six inches long, and half an inch broad; if reduced into leaves under the gold beater's hammer, it is capable of still further extension; its tenacity, however, bears no proportion to its ductility, being less than even that of iron or copper. A silver wire, one tenth of an inch thick, will scarcely bear a weight of two hundred and seventy pounds, while a gold wire of the same thickness will support nearly double that weight.—*Saturday Magazine.*

HAND-WEAVING.

THERE is, perhaps, no art more generally practised, nor any which has conduced more to the comfort of mankind, than that of weaving, and its antiquity is so great, that to endeavour to trace out the original inventor, would be a hopeless task. The principle of weaving is the same in every kind of fabric, and consists in forming any description of fibres into a flat web, or cloth, by interlacing one with another; the various appearances of the manufacture arise as much from the different modes in which these fibres are interwoven, as from the difference of material.

The simplest weaving loom, although far from being in reality a complicated machine, is yet necessarily formed of so many pieces, that any view that can be given of it would be insufficient to render the process intelligible.

The material which forms the length of the cloth is called the warp, and the various threads of which it is composed are wound singly round small wooden reels called bobbins. A certain number of these is taken by the warper, who prepares the threads for the weaver, and who arranges the bobbins. The number of bobbins taken up at one time in silk-weaving is fifty, twenty-five of which are placed on the lower beam, and as many on the upper; the thread from the bottom row passes over the lower bar, and that from the upper over the upper bar; these threads are then tied together, passed between two pulleys to the warping mill, on which the warp has now to be wound, and there placed on a pin. The warper now passes her fingers between the threads of the warp, taking, alternately a thread from the upper and lower row of bobbins, and slides her hand along, until she reaches the pin over which the ends of the warp, which are tied together, are passed. They are then wound on a roller, side by side, and to the "loom" or machine for weaving, through which they run, also side by side. Near the end they are attached to "healds," or threads stretched in an upright frame, with loops in their centres. In plain weaving, a pair of these frames is used, one half the threads of the warp passing through the one frame, and the other halt through the other, alternately, thus—first a thread is passed through the loop of one heald, and then the next goes through a loop of the other heald, and so on. These healds are so fixed that they can be raised alternately—one raising every alternate thread.

The warp upon the cylinder having been equally spread over its surface, and two long sticks introduced between its alternate threads, to supply the place of the two pins on the warping-mill, it is now prepared for the weaver, by straining it tight, by means of weights properly applied at one end. Machinery which is connected with treadles, which the weaver presses with his foot alternately, raises first one half of the threads of the warp and then the other, each time so far separating them as to allow the shuttle to pass, and carry with it the cross threads of the cloth, called the *woof.* The thread of the woof, which crosses the cloth, is wound round the pointed bobbin in the inside of the shuttle, and as this is thrown with a sudden jerk, between the separated threads of the warp, of course it unwinds, and the shuttle passes on to the other side of the cloth; the threads of the warp are again shifted by the treadles, and the shuttle is returned, forming the second thread of the woof, and this raising and depressing the alternate threads of the warp, and passing and repassing of the shuttle, is continued, until the piece of cloth is finished; this is called plain weaving, and the threads of the warp and woof would appear, if magnified, quite intricate.

In some kinds of work, instead of the woof passing between every other thread of the warp, it will pass under one and over three; it is in this case called *twill,* and this kind of fabric is considered stronger than plain weaving, from the threads of the woof lying closer together. There is another kind of *tweel,* in which the thread of the woof is of a different colour to that of the warp, this produces a pattern. In some instances the threads are made to cross each other in a peculiar manner, producing different kinds of fabrics, as mail-net and gauze; here, at each place where the threads cross, they are curiously twisted or tied. In this the machinery of the loom is much more complicated, and the treadles that separate the warp more numerous.

In the weaving of carpets the warp is double, and the thread of the woof passes from the upper to the lower portion at various points, according to the pattern; in the smaller patterns, these points are more numerous than in the larger, and consequently, a carpet of a small pattern is (the quality of thread being equal) considerably stronger and more durable, than one in which the design is of a larger character. The weaving of damask patterns is extremely complicated, and the preparing the warp to receive the woof, and calculating the order in which the woof is to be thrown, will employ a man for six weeks or two months.

In the weaving of cotton goods, a preparation of flour and water is used, for the purpose of giving consistency to the thread of the warp; this preparation is applied by means of a large brush, as it is necessary that the warp should be kept constantly moist and pliable, and in extremely hot weather, there is much difficulty in producing this effect. The silk weavers, in Spitalfields, had a curious method of keeping the warp in this state: instead of flour and water, a kind of size was prepared by boiling cuttings of kid-leather in water; this is called *sprew:* the workman takes a quantity of this liquid into his mouth, and blows it through his lips in such a manner, as to make it fall upon the warp in the form of a fine rain.

There is no doubt, that the complicated machinery employed in the English looms, can produce the finest and most beautiful fabrics in the world; but while we look with amazement at the result of the labours of our countrymen, we cannot withhold our astonishment at the elegance and regular texture of the goods produced by the patient Hindoo, whose loom consists of little else than a few sticks of bamboo, rudely fastened together, and fixed to the branches of some leafless tree. —*Saturday Magazine.*

KING HENRY THE EIGHTH.

Kath. If my sight fail not,
You should be lord ambassador from the emperor,
My royal nephew, and your name Capucius.
Cap. Madam, the same, your servant.
Kath. O my lord,
The times and titles now are altered strangely
With me, since first you knew me. But I pray you,
What is your pleasure with me?
Cap. Noble lady
First, mine own service to your grace; the next
The king's request that I would visit you;
Who grieves much for your weakness, and by me
Sends you his princely commendations,
And heartily entreats you take good comfort.
Kath. O my good lord, that comfort comes too late;
'Tis like a pardon after execution:
That gentle physic, given in time, had cur'd me;
But now I am past all comforts here, but prayers.
How does his highness?
Cap. Madam, in good health.
Kath. So may he ever do! and ever flourish
When I shall dwell with worms, and my poor name
Banish'd the kingdom! Patience, is that letter,
I caus'd you write, yet sent away?
Patience. No, Madam.
(*Giving it to Katherine.*)
Kath. Sir, I most humbly pray you to deliver
This to my lord, the king,
Cap. Most willing, Madam.
Kath. In which I have commended to his goodness,
The model of our chaste loves, his young daughter,—

The dews of heaven fall thick in blessings on her!—
Beseeching him to give her virtuous breeding;
To love her for her mother's sake, that loved him,
Heaven knows how dearly. My next poor petition
Is, that his noble grace would have some pity
Upon my wretched women, that so long
Have followed both my fortunes faithfully;
The last is, for my men;—they are the poorest,
But poverty could never draw them from me;—
And, good my lord
By that you love the dearest in this world,
As you wish Christian peace to souls departed,
Stand these poor people's friend, and urge the king
To do me this last right.
Cap. By heaven I will;
Or let me lose the fashion of a man!
Kath. I thank you, honest lord. Remember me
In all humility unto his highness;
Say, his long trouble now is passing
Out of this world; tell him, in death I bless'd him,
For so I will.—Mine eyes grow dim,—Farewell,
My lord,—Griffith, farewell. Nay, Patience,
You must not leave me yet, I must to bed;
Call in more women,—When I am dead, good wench,
Let me be us'd with honour; strew me over
With maiden flowers, that all the world may know
I was a chaste wife to my grave; embalm me,
Then lay me forth; although unqueen'd, yet like
A queen, and daughter to a king, inter me.
I can no more.—*Shakespeare.*

THE HISTORY OF THE MANUFACTURE OF GLASS.

PART I.

THE invention, or rather the discovery of glass, is said to have been accidental. The account given of the occurrence is, that a merchant vessel, laden with saltpetre, having been driven on shore on the coast of Palestine, the crew placed the kettles, in which they had cooked their victuals, on some lumps of their cargo, which, being melted by the action of the fire, combined with the sand on the beach, and formed a kind of glass.

The art of rendering glass transparent was not discovered till several centuries later. To whom we are indebted for this valuable discovery is uncertain; but we find it is recorded in history, that Nero, the despotic Roman Emperor, paid a sum of money, nearly equal to £50,000 sterling, for "two small cups of transparent glass."

Amongst the ancient ruined cities of Egypt, articles made from glass have been found; thus the eras which beheld the erection of the pyramids, may also have witnessed the less astonishing but more useful operations of glass-making. The manufacturers of ancient Tyre were not ignorant of this beautiful substance, which they probably distributed to distant regions of the world, by their widely-extended commerce. Even amongst the ancient Chinese we find traces of this art, and a diminutive vase, of a bluish-white colour, made from this ancient Chinese glass, may be seen in the British Museum. It is well known that the Romans possessed glass vessels, as urns of this substance have been found in Herculaneum, and some of these are deposited amongst the antiquities of the Museum. The beautiful Portland Vase is formed of dark blue glass, and is supposed to have been the work of an ancient Greek artist, who must have been versed in the manufacture of the substance from which the vase is formed.

At the beginning of the Christian era, the art of glass-making appears to have made considerable progress, and, at the end of the 3rd century, we find a notice of its being used, in some cases, for the purpose of glazing windows. The invention advanced rapidly in Italy, and afterwards in France; but the first account we have of the use of window glass in England is in the year 674, when the Abbot Benedict Biscop sent over for foreign artists to glaze the windows of the church and monastery of Wearmouth, in Durham; yet, although thus early known, it was not employed for this purpose in private houses, or even in churches and cathedrals, in this country, till the end of the 10th century.

Venice ranked this manufacture amongst the sources of her wealth, and guarded the secrets of the process with as much jealousy as she watched the actions of her dukes. Some remains of this art are still preserved in Muráno, a town about a mile north of Venice. In England some large manufactories were fixed in London, (at Crutched Friars and the Strand,) about the middle of the 16th century. How little the art had been previously practised in this country, may be understood from the high value and rarity of glass windows in English houses. Few circumstances illustrate this more strongly than the custom of removing such windows from the casements, and packing the frames in boxes, whenever the family removed from one habitation to another, as from a country to a town residence. But, if glass was rare and costly in the time of Elizabeth, the tastes of the people were not such as to encourage a great increase of the production from the few manufacturers. This slow advance of the art did not solely arise from the absence of patronage on the part of the government, for James I. gave a patent for the manufacture to Sir Robert Mansell; and the Duke of Buckingham, introducing skilful workmen from Venice in 1670, established a manufactory at Lambeth, where may still be seen the furnaces of the glass-houses in operation. The existing manufactories are not the direct successors of those supported by the duke, who was too deeply involved in political intrigue at that time, to give much attention to the useful arts: his works at Lambeth were, therefore, neglected, and, after a short period, wholly abandoned.

Formerly every description of flat glass had been *blown*, in the manner we shall presently explain; but in 1688, a very great improvement was made by one

Abraham Theveuart, who resorted to the plan of *casting* plates of glass for looking-glasses and other purposes. A large manufactory was established at St. Gobin, in the department of the Aisne, in France, which is still deemed one of the most considerable in Europe.

The manufacture continued to advance, though slowly, and glass became a taxable article in the time of William III.; whilst, in the Reign of George II., the raw materials were made subject to a higher excise duty. The first large manufactory was established at Ravenhead, near St. Helen's, in Lancashire, where the "Governor and Company of the British Cast Plate-glass Manufacturers," gave a decided impulse to the production of the material in Britain. This society obtained a royal charter, and the sanction of Parliament for its operations in 1773. The works covered about twenty acres of ground, and nearly 300 persons were constantly employed there on this manufacture.

Thus, at the very period when Hargreaves and Arkwright were developing the capabilities of cotton machines in one part of Lancashire, the capital of this company was, in another part of the same county, giving the necessary stimulus to the production of glass.

PART II.

Glass in general consists of two bodies united by the agency of a third; these two being sand, and some alkaline substance; and the uniting matter, or the *flux*, is usually lime. Suppose a quantity of flinty sand is mingled with soda or potash; these will not be fused without the aid of a flux, which effects that singular union between the two substances, from which another, so totally distinct from each, arises.

Glass, then, consists essentially of *silex* (the substance of which flint is formed), and some of the various kinds of *alkali*, as *pearl-ash*, *potash*, *kelp*, &c. The use of the alkali is to cause the flint to melt when in the furnace.

The best form in which flint is met with for the purpose of making glass, is in the state of sea-sand; and those kinds best adapted to the purpose in England, are procured from Lynn, in Norfolk, and from Alum Bay, in the Isle of Wight.

The first process consists in what is called *fritting*, that is, placing the materials in a crucible, and submitting them to the action of a violent heat, for the purpose of driving-off any moisture they may contain, and to prevent their swelling too much when placed in the melting-pots, which are formed of a kind of clay that is able to endure the action of fire without melting. When the materials are sufficiently *fritted*, they are thrown into these pots with clean iron shovels, the fire being previously raised to its greatest intensity, to prevent the whole furnace from being chilled, and to save time. As the fritted materials are much more bulky than when they fall into a thin flowing glass, the pots receive their full charge by two or three successive portions, the last added being always thoroughly melted down before a fresh charge is thrown in. When full, the opening in the pot is closed with red clay, except a small hole for examining the work, and when the glass is well refined, and about to be worked off, this opening is again enlarged by the removal of the clay.

The crucibles, or pots, in which the glass is melted, are of an upright form, with the opening on the side near to the top; they are arranged in a circle, and built into a conical furnace, the walls of which are in the form of a sugar-loaf.

The kinds of glass manufactured are of various qualities, the commonest being that of which wine bottles are made.

Windows and plate-glass are both considerably harder in texture and more brittle than that which is called *fluid-glass*, of which wine-glasses and decanters, lamp-glasses, &c., are made. Various contrivances are made use of for the purpose of forming them into different shapes, but the material parts of the operations are much the same as those already mentioned. In some instances, brass moulds are employed, into which the different articles are blown, and in this manner many excellent imitations of cut glass are formed.

1. *Flint Glass.*—This was originally named from the flint formerly used in its manufacture, but which is now superseded by fine sand, selected with care from various districts. Sand, pearlash, and litharge, are the materials *generally* employed for the production of flint glass; but different manufacturers use various proportions of these substances, as their scientific knowledge or experience may suggest. Some skilful glass-makers fuse together one hundred parts of Lynn sand, sixty parts of litharge, and thirty of purified pearlash.

When the materials have been submitted to the action of the fire for a certain time, varying from thirty to thirty-six hours, they have become perfectly liquid; the fire is then damped, and the glass in this fluid state, is suffered to cool to such an extent as to become sufficiently thick to be taken up on the end of an iron rod. When in this state there is perhaps no substance in nature so ductile, or so easily moulded into any form that may be required.

2. *Crown Glass.*—This, though not so rich as the preceding, must not be passed over in silence, being the best species of window glass, and therefore contributing to the comforts of all those numerous families who inhabit the better class of houses. It is also composed of different materials from flint or plate-glass, for, whilst much metal enters into these, little is allowed to mix with the ingredients from which crown glass arises. It is, therefore, much lighter and harder than those kinds into which so softening and heavy a substance as litharge (oxide of lead) enters. The substances used by different manufacturers vary exceedingly in their proportions, each having his own pet system of working. The best French crown glass is formed from one hundred parts of fine white sand, added to the same quantity of broken crown glass, and with these elements twelve parts of carbonate of lime, and four times that

amount of carbonate of soda, are mingled. But in this country the following proportions are frequently used:—

Sand, ...	200 lbs.
Kelp, ...	330 ,,
Lime, ...	15 ,,
Broken crown glass, ...	200 ,,

When superior glass is required, other proportions are employed, whilst pearlash and saltpetre are substituted for the *kelp*. What is this kelp, which we have not hitherto had occasion to mention? It is the ashes of sea-weeds, which were formerly gathered in large quantites along the shores of Ireland and Scotland, and in some places *cultivated* by the landowners with the greatest care. But the alkaline matter, resulting from the burning of kelp, was too coarse and impure for use when a superior glass was required, and it is now rarely employed except in cases when fine material is not the object. The introduction of Barilla* at a moderate duty from abroad, and the reduction of the duty on salt, from which alkali for the glass-works is now made, have freed our manufacturers from the necessity of using kelp in their operations.

The wonderful ductile property of glass, cannot, perhaps be exhibited to greater advantage than when the workman avails himself of it in the manufacture of crown glass. His mode of proceeding is, in the first place, to dip a long iron tube, called *panten* or *the punt*, the end of which has been previously heated, into the melting-pot, and to take out as much glass as will adhere to it; this operation he repeats until his judgment tells him he has sufficient metal on the end of the tube to form the table of glass he is about to blow. He then moulds the metal into a regular form by rolling it on a smooth iron table; when this is accomplished, he blows through the tube and forms the glass into a hollow vessel, shaped like a pear. He continues to enlarge this form by alternately heating the glass, and blowing through the tube; at the same time lengthening the neck, by rolling it on an iron rod, fixed to a kind of seat. It is now carried to the mouth of a larger furnace, called the *bottoming-hole*, in front of which a low wall is built to protect the workmen from the heat; it is here again heated, and whirled round with a slow and steady motion. The effect of this is to flatten the wide end of the glass, owing to the tendency of the metal to fly from the centre on which it revolves, in the same manner as the water does from a wet mop when twirled on the wrist.

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* A carbonate of soda, imported in large quantities from Spain, Italy, Sicily, and the Canary Isles, obtained from two plants, one of which is called *Barilla*.

A second workman now comes to the assistance of the first, and having taken up a portion of the metal on the end of an iron rod, smaller and lighter than that first used, he applies it to the centre of the flat bottom of the glass held by the other, to which it adheres. The first workman now touches the glass where it is attached to his blowing tube with a cold iron rod which has been dipped in water, this causes the glass to crack, and the blow-pipe is easily detached. Taking hold now of the smaller rod, he presents the broken end of the glass to the heat of the furnace, and continues the whirling motion; the effect of this is to enlarge the opening or mouth of the vessel. As the work proceeds, the workman impels the glass round with greater rapidity, till at length the blazing metal flies out with a jerk, with great force, and with a loud ruffling noise, like the rapid unfurling of a flag in a strong breeze. This part of the process is called *flashing* the glass. The sudden extension of the glass in this part of the process is sure to strike the spectator, who sees it for the first time, with surprise, and induces him to expect that the glowing mass will be torn to pieces by the violence of the shock. It is now moved more slowly round, till it is sufficiently cool to retain its form; the rod is then broken off in the same manner as before, and the circle of glass is carried to the *annealing-furnace*, where it is gradually cooled. The knot which is found in window-glass, shows the spot from which the iron was broken.

PART III.

There is a kind of glass called German plate, (much thinner than the genuine plate-glass) which is made by blowing the metal. The metal is first blown into a long pear-like shape, one end of this is pierced with an iron instrument, and the opening is afterwards enlarged by the same means. A slit is now made with a pair of shears through half its length, and the iron instrument having been dipped in the melted metal, is applied to the open end. The iron rod is now broken off, and the opening enlarged to the same size as that at the opposite end; the form is now a perfect cylinder like a roll of paper. The slit is now continued the whole length, and being laid upon a smooth iron table, it falls flat like a sheet of paper.

Plate-glass.—The production of this costly material demands far greater care than the preceding kinds, both in the selection of the ingredients, and in the careful fusion of the mass and rolling of the plates. To make 1,200 lbs. of plate-glass 1,700 lbs. of material is required, made up of the following substances mixed in proper proportions:—

	Lbs.
Lynn Sand,	720
Fine Soda,	450
Slaked Quicklime,	80
Nitre,	25
Old plate-glass broken up,	425
	1,700

It will be seen that exactly one quarter of the whole is old glass, without which the quality required cannot be produced. When heated to a liquid mass, the whole is laded out into a vessel called a *cuvette*, from which, after being further heated, it is poured on to the surface of a long table, made of copper, when a heavy polished copper roller is passed over its surface, reducing it in this manner to an equal thickness over its whole area. The operation of casting takes place close to the mouth of the *annealing-furnace,* into which it is carried immediately it becomes solid. But the large plates of glass are by no means fitted for use when withdrawn from the *annealing oven;* three processes are yet necessary before they reflect the clear image from the silvered mirrors, or adorn the windows of our mansions. They are first cut by the diamond to the shapes required, an operation requiring no description here. The plates are now ground, to remove the roughness found on the surfaces. This work requires great care, it being necessary to plane off the roughness without scratching the face of the glass. Some powdered flint is therefore spread over the plate, and rubbed along the surface by machinery, which, in the larger glass-houses, is moved by steam. After the flint has removed the larger protuberances, emery powder is applied, first coarse, and then finer, until by successive frictions the plate begins to exhibit a beautiful level.

But all is not yet done; the *polishing* now follows. In this operation, pieces of wood covered with numerous folds of cloth, with wool between the folds, are used to bring the finished plate to its last degree of beauty. The friction of these cloth rollers would not, however, be effective without the use of a peculiar substance, called colcoth (the red oxide of iron), used for polishing other hard surfaces besides those of plate-glass. Thus, from the fusion of the Lynn sand, the soda and lime, arises the product, which, having passed through the *annealing-oven,* the grinding, and the polishing, is now to take its place amongst the highly elaborated productions of art.

The various kinds of glass we have been speaking of, possess different properties, according to the purposes to which they are to be applied. Flint-glass, of which most ornamental articles are made, is rendered softer than the other sorts, and plate-glass, on the contrary, is made of as hard a texture as possible, to prevent its being easily scratched.

We have already spoken of the glass being placed in the *annealing-furnace* which might more appropriately be called an *oven*, since a low red heat is the highest degree to which it is ever heated. The purpose for which the glass is placed in this furnace, is to allow it to cool gradually down to the temperature of the air, by first placing it in the hottest part of the oven, and afterwards gradually removing it to the mouth.

For some of the larger pieces of plate-glass, this operation will occupy the space of two or three weeks If glass is not properly annealed, the most trifling scratch or blow from a sharp body, or any sudden change from heat to cold, will cause it to break. If suddenly cooled in making, without undergoing the process of annealing, this brittle property is increased to an extreme degree.

Two philosophical toys, one called the Bologna Phial, and the other, Prince Rupert's Drops, or commonly the *hand-cracker*, are good instances of this.

The Bologna Phial, is merely a wide mouthed bottle of unannealed green glass, extremely thin at the neck and upper half of its sides, and very thick below. A leaden bullet may be dropped into this bottle from the height of several feet without danger, but if a large grain of sand, or, what is better, a small piece of broken gun-flint is allowed to fall into it through the space only of a few inches, the shock produced will break the bottle to pieces. If laid on its side, the thick end may be struck with considerable force with a wooden mallet without danger; but it would be immediately broken, if merely scratched with a piece of sand.

The hand-cracker is a very familiar instance of this property; the thick end of this may be laid on the table, and struck forcibly with the fist without danger, but if it is grasped in the hand, and the smallest portion of the thin end is broken off, the whole of it breaks to pieces, or bursts, with so much violence as to sting slightly the hand that holds it.

The purposes to which this beautiful material have been applied, are as numerous as they are useful; it has added materially to the comforts and conveniences of private life; it has, among many other invaluable benefits, assisted the astronomer in his researches, and the philosopher in the detection of the more minute operations of nature among the lower classes of animals; and to it we are indebted for our chief discoveries in electricity.—*Saturday Magazine, and Sharpe's London Magazine.*

MANUFACTURE OF HORSE-NAILS.

THE fabrication of the nails used in shoeing horses is a large and highly important branch of industry, which until lately has resisted all the attempts of inventors to elevate it from a handicraft into a manufacture. The horse-nail must combine many peculiar features. It must be easily flexible, and must bend without any tendency to crack. It must be of small bulk, and so sharp, that notwithstanding its flexibility, it will readily penetrate the hardest hoof. It must be so tough and strong as to withstand, especially at the junction of the head and shaft, all the shocks and friction incidental to travel or to draught. These qualities can only be obtained from charcoal iron of the very finest quality, and have hitherto been obtained only from nails forged by hand from rods. In the course of the present century no less than thirty-one patents or provisional protections have been obtained for horse-nail machinery, but although many of these patents possess considerable merit, not one of them has ever reached the stage of being actually worked for commercial purposes. In the earlier ones it was usually proposed to punch the nails out of sheets, but sheet iron cannot be obtained of the quality required, and the process of punching is one that would imply considerable waste. Other inventors attempted to substitute rollers for the hammer of the smith, and to roll out the end of the heated rod to the necessary point. The endeavour failed because the rollers were found to carry a sort of wave or projection of the heated iron before them, and this was apt to crack on cooling and to render the finished nail worthless. Other contrivances fell through for various reasons, often because the inventors knew only the shape of the horse-nail, and were unacquainted with the actual requirements of the farrier, and often, perhaps, for want of the capital necessary to establish them. The horse-nail business has remained in the hands of masters residing chiefly in and about Birmingham, Derby, and Bristol, whose practice it is to give out iron rods to workmen, who forge the nails at their own homes. A skilful workman can make 1,000 nails a day, and is paid 3s. 6d. for this quantity; but, as a matter of fact, few men can continue at this speed of production for many consecutive days, so that the wages paid do not average a guinea a week. This is a very low rate for skilled artizans, and it is said not to be uncommon for the men to sell the fine iron supplied to them by their masters and to forge their nails out of iron of an inferior quality. There are in Great Britain and Ireland about 2,600,000 horses, which represent a demand of about 998 millions of nails (or 5,574 tons) per annum. More than 2,000 tons are made for exportation; and, at an average of £60 per ton, the annual value of the trade is little less than half a million sterling.

Among the more recent patentees of horse-nail machinery are the Messrs. Huggett, father and son, the former of whom has been extensively engaged in shoeing horses for many years.

The chief feature of Mr. Huggett's patent is a pair of rollers by which he converts ordinary rod iron into a rod so shaped as to admit of being cut into nail blanks. The upper roller is a simple cylinder; the lower has a series of depressions on its circumference, separated by intervals. Each depression corresponds to two nail heads, each interval to two shanks; and the surface of the roller is so curved in the intervals as to render the middle of each its most prominent part. The actual roller surface is very narrow, corresponding to the slenderness of the rod; but is bounded on either side by a massive collar, which prevents the smallest lateral spreading of the iron, and limits the alteration of its form to elongation. In order that the iron may yield freely, a very high degree of heat and a rapid motion are necessary. The rods, each two feet in length, are heated in a gas furnace, and are then suffered to run down a shoot to the rollers, which are turning at the rate of 500 revolutions a minute. The lateral collars already mentioned are so contrived as to present the descending rod always in the right direction to the rollers, and it appears almost instantaneously on the other side, still glowing, somewhat contorted, and about trebled in length. It falls into a sort of trough, and is instantly seized with proper tongs by two boys, one at each end, is pulled straight, and laid aside to cool. The rollers are kept constantly lubricated by a stream of coal tar, which at once diminishes friction, and also, by inflaming as each rod is passed through, shields the faces of the rollers by a fine carbonaceous deposit. A single furnace will heat from five to six thousand rods per day of ten hours, a quantity equivalent to over 100,000 nail blanks; and the rollers, which are rather under 7 inches in diameter, could turn out rods at the rate of 900 ft. per minute.

The rod of nail blanks, as it leaves the rollers, may be described as a slender strip of iron, presenting a series of prominences on one side. Each prominence is about 1¼ in. long, each interval between the prominences about 3½ in., the dimensions varying slightly with the size of the nail that is to be made. From each prominence the rod tapers slightly to the centre of each interval. It is nearly as flexible as lead, and so tough that the most rapid bending to and fro only breaks it with difficulty.

In this state the rod is passed cold through another pair of rollers, so contrived that they compress only the prominences, and give them a nearly square outline in section. It is then taken to a cutting machine and cut into lengths by descending blades. These blades are three in number—two lateral, at right angles to the rod, each of which cut straight through the centre of a prominence, so as to divide it into two nail heads; one central, set obliquely to the rod, so as to divide each interval into two bevelled points. The pieces, now called nail blanks, are next put into a machine like a huge coffee-roaster, which is kept turning in order that they may clean and polish each other by mutual friction.

The cleaned nail blanks still require to receive their perfect shape, and for this purpose they pass through two machines, the first of which gives a generally pyramidal figure to the heads, while the second finishes the shape in all respects. The first, or heading machine, consists of a massive die, which rises and descends in a vertical line. Beneath it a wheel turns intermittently on a horizontal axis, and from the circumference of this wheel project several pairs of dies, which receive the nail blanks point downwards. When the vertical die descends it finds one of the pairs of wheel dies beneath it to receive the stroke; and each stroke of the vertical die is followed by a partial revolution of the wheel, which brings the next pair of wheel dies to receive the next blow. The wheel dies consist of blocks of iron hollowed out on their opposing faces to receive the blanks, and hollowed at the top into the proper shape of the heads. The two blocks are kept somewhat apart by spiral springs inserted between them, so that they hold the nail blank loosely; but as each pair in succession reaches a vertical position, and just before the plunger descends, a pair of grippers closes upon the blocks and squeezes them tightly together, so that the blank is held securely to receive the blow. As the plunger rises, the grip is relaxed, and the blocks are again separated by the springs. As the wheel passes on, each pair of blocks receives, in its turn, a tap from a mechanical hammer, by which the nail blank is loosened, so that it falls out as soon as its head is directed downwards by the continued revolution of the wheel. The machine is supplied by one girl, who sits by the revolving wheel, and places nail blanks in the wheel dies as they successively ascend towards her. A single machine is capable of heading from 22,000 to 24,000 nail blanks in a day of ten hours.

The shaping machine bears a great general resemblance to the foregoing. The nails are carried up, one by one, on the circumference of a wheel, on which they are retained by stops, and are presented in succession to the pressure of a descending plunger and of two lateral dies, which between them remove all irregularities or inequalities of form, and produce a nail of perfect finish and outline. Lastly, the nails are annealed and coloured, and are then ready for the market.

With the exception of the men employed at the rolling mill and the annealing furnaces, the work of the factory is mainly done by girls, most of whom were employed, until recent changes, in Woolwich Arsenal. Besides the saving thus effected in the cost of labour, there will also be an important saving in material. In hand-made nails the waste of iron is not only very considerable, but is absolute, and cannot be recovered. In Mr. Huggett's process there is a primary waste of about 24 per cent. of raw material; but 19 per cent. of this is in the shape of odd lengths of metal, defective nails and so forth, all of which can be again worked up and rendered useful. The irrecoverable, or fire waste, does not exceed the remaining 5 per cent. By means of these elements of saving, Messrs. Moser expect to be able to sell at about 10 per cent. less than the cost of the cheapest hand-made nails, and as none but the very finest iron would lend itself to their rolling process, the quality of the metal is uniformly of the best. The machine-made nails may be bent two and fro upon themselves without breakage, twisted in every conceivable way, or beaten out into sheets as thin as writing-paper without cracking at their edges. The whole process is a triumph of mechanical ingenuity, the more curious and interesting that it has been so long delayed.—*The Times.*

THE ATMOSPHERE AND ITS MOVEMENTS.

AROUND the earth, over sea and land, extends a vast expanse of gaseous matter; it is known as the atmosphere, through whose instrumentality all life exists. The *atmosphere*, (or as we generally call it *the air*,) consists of a compound of gases, the two chief being oxygen and nitrogen, which are mixed together in the proportion of seventy-nine of the latter to twenty-one of the former. Many substances pass into our air in a gaseous state, and make their presence felt, so that we can very seldom obtain thoroughly pure air. Flowers diffuse their odours through it: the breath expelled from the human body poisons it.

The atmosphere performs most important offices; and since it is everywhere existent it is *all*-important. The tree or flower yields up its oxygen to the air, which transfers it to man, thereby strengthening and reinvigorating him. Man expels from his frame carbonic acid, which the air carries to the plant, thereby refreshing it, so that man and plant perform mutual offices the one for the other.

The atmosphere extends above the earth for a distance of forty-five miles. It is very elastic, hence the densest part will be at the sea-level, where the weight of a column of air of the atmosphere's entire height has to be sustained. The pressure at the sea-level is at the rate of fifteen pounds to the square inch. We are not conscious of this pressure, because natural laws prevent our feeling it. "The little limpet, however, feels it, and makes use of it too, when he sticks so hard to the rock, that you cannot pull him off. By a peculiar faculty he removes the air and water from between him and the rock, and it is then simply by atmospheric pressure that he clings so tightly."

Any considerable change in the lightness or heaviness of the air, would be fatal to animals. Those who climb very high mountains, and thus reach the higher and thinner parts of the air, find a greater difficulty in breathing, are unable to exert themselves, to lift weights, or even to stoop, and sometimes are compelled to come down, from the danger of breaking some blood-vessel, in consequence of the outward pressure of the air being taken off. On the other hand, those who go down in diving-bells, and have the air which they breathe, pressed into a narrow space by the water above them, find inconvenience from that cause.

I. One most useful property of the air is to convey sounds, not only in a rude way, by making us hear loud noises or low murmurs, but by exactly representing those most delicate inflections of voice, which constitute speech. It can be proved by direct experiment made by the air-pump—a machine by which the air can be drawn out of a large glass receiver—that if a bell be hung in such a glass, and the air be pumped out, there is no *sound* whatever produced, although the clapper be struck against the bell. Sound is, in fact, a vibration something like waves, carried along from one part of the air to another. It does not move so fast as light, as anyone may perceive, who observes a gun fired from a considerable distance. He will see the flash some time before he hears the report, just as we hear the *roar* of thunder some seconds after we see the lightning.

The air, then, which we breathe, is exactly fit for conveying such sounds as our voices are able to produce, and our ears are fitted to hear. But it is not *every* kind of *air* which will do this. If a man's lungs are filled by breathing some gases, which can be produced by chemical means, the sounds which his voice is able to make can scarcely be heard. And no doubt this difference would be much more perceptible, if the *ears* were also surrounded by such an elastic fluid, instead of common air.

Without the air, we should be in a state of utter silence; and if it differed much from what it is, we should never have conversed. All language, all communication of thought by speech, could never have existed. And without speech, what would have been the condition of mankind?

II. The air has also very material influence upon our sense of sight. It is by the action of the atmosphere only, that the change from day to night comes on so gradually, indeed so imperceptibly, that the eyes easily accommodate themselves to it. Had we little or no atmosphere, the rising of the sun would cause a sudden change from utter darkness to the light of the brightest noon: and at his setting, we should again be *instantly* left in darkness. It is almost needless to observe with how much beauty this beneficial change is now accompanied. All the glowing colours which decorate the heavens, at the rising and the setting sun, the thousand brilliant hues in which the clouds are bathed, are all owing to the atmosphere.

Colours are given to various objects by their absorption or reflection of certain rays. A red object is red, because it absorbs into itself the rest of the primary colours, and reflects the red. Another object is violet, because it reflects only the violet rays. A black object is black because it *absorbs all* the colours, while a white object *reflects* all the colours. You can see the seven primary colours in the rainbow. You can easily see how the union of the colours makes white, by painting a top with the seven colours and then spinning it; as the top goes round, the colours will appear to blend together, and the top will look as if it were painted of a dusty-white colour.

III. Again, the atmosphere is the agent by whose means we receive light and heat. Both consist in the communication of motion from the sun; certain vibrations produce light, while others produce heat: but all bodies do not allow heat and light rays to pass through them. Had the earth been surrounded by glass instead of air, we should have received all the light that proceeds from the sun, but none of the heat. Air is both transparent like glass, and a conductor of heat like rock-salt.

It is by means of the atmosphere that we are able to see objects in the day-time, in whatever part of the sky the sun may be. No object can be seen except by the light which it reflects or suffers to pass through it, unless, indeed, it be seen as a dark spot, intercepting the light which comes from some other object. Now the air *reflects* light in all directions, so that some light always falls upon what would otherwise be the dark side of an object, and renders it visible. We can scarcely bring ourselves to imagine what would be the appearance of the most familiar objects, if those parts of them only were visible, upon which the direct light of the sun, or the light reflected from other large objects fell. But they would certainly appear very distorted; and their shapes would probably be so strange, that we should scarcely recognize them. Besides this, all the part of the sky, except that in which the sun happened to be, would, without the atmosphere, appear totally dark, even at noonday.

All the properties of the atmosphere which we have hitherto noticed, might, for anything we know, have belonged to *dry* air. But this would have fallen far short of supplying the wants of other parts of the creation. Water always runs to the lowest level; but, as all animals and vegetables require a constant supply of moisture, some means were necessary by which the water, which is always running down to the ocean, should be pumped up again, and, what is more, should be pumped up *fresh.* The invisible atmosphere about us supplies the machinery by which this great natural process is effected. Besides the dry air which it contains,—consisting, as we have seen, of different parts,—there is also in the atmosphere a quantity of *vapour of water*, which is invisible, except under peculiar circumstances. In the very driest weather, the presence of this vapour can be detected, by cooling a body till either a *dew* or *ice* settles upon it. This vapour is constantly rising from the sea, and from the surface of the land: and, what is very remarkable, the salt of the sea-water is *left behind* in evaporation. It is this vapour which forms clouds, tempering the extreme heat and dazzling light of the sun's direct rays. The same source supplies the materials for rain, hail, snow, mist, dew. Thus, moisture is present everywhere, ready to supply the constant wants of plants and animals.

We cannot but observe the wisdom which is found in this part also of the Creator's works. Had we been told that water was to be carried about everywhere, and at all times, through the air, we should probably have expected an atmosphere of thick fog, through which the light of the sun could scarcely have penetrated. And it is an additional reason for wonder and thankfulness, when we see all the useful purposes of an abundant supply of water effected, without any injury to the other properties of the atmosphere, without usually affecting its transparency, without ever interfering with its power of supporting respiration, of conveying sound, or of reflecting light.

LORD WILLIAM.

No eye beheld, when William pushed young Edmund in the stream;
No human ear but William's heard young Edmund's drowning scream.
Submissive, all the vassals owned the murderer for their lord;
And he—as rightful heir—possessed the house of Erlingford.

The ancient house of Erlingford stood in a fair domain;
And Severn's ample waters near, rolled through the fertile plain.
But never could Lord William dare to gaze on Severn's stream;
In every wind that swept its waves, he heard young Edmund scream!

In vain, at midnight's silent hour, sleep closed the murderer's eyes;
In every dream the murderer saw young Edmund's form arise!

Slow went the passing hours, yet swift the months
appeared to roll;
And now the day returned, that shook with terror
William's soul—
A day that William never felt return without dismay;
For, well had conscience calendar'd young Edmund's
dying day,
A fearful day was that! the rains fell fast with tempest
roar,
And swollen tide of Severn spread far on the level
shore.
In vain Lord William sought the feast, in vain he
quaffed the bowl,
And strove, with noisy mirth, to drown the anguish of
his soul—
The tempest, as its sudden swell in gusty howlings
came
With cold and death-like feelings, seemed to thrill his
shuddering frame.

Reluctant now, as night came on, his lonely couch he
pressed;
And, wearied out, he sank to sleep,—to sleep—but not
to rest!
Beside that couch, his brother's form, Lord Edmund
seemed to stand!
Such and so pale, as when in death he grasped his
brother's hand;
Such and so pale his face as when with faint and faltering tongue
To William's care—a dying charge!—he left his orphan
son.
I bade thee with a father's love my orphan Edmund
guard—
Well, William, hast thou kept thy charge! now take
thy due reward!

He started up—each limb convulsed with agonizing
fear:
He only heard the storm of night,—'twas music to his
ear!

When, lo! the voice of loud alarm his inmost soul
appals:
"What, ho! Lord William, rise in haste! the water
saps thy walls"
He rose in haste:—beneath the walls he saw the flood
appear!
It hemmed him round—'twas midnight now—no human
aid was near!

He heard the shout of joy!—for now a boat approached
the wall;
And eager to the welcome aid they crowd for safety
all,—
"My boat is small," the boatman cried, "twill bear but
one away;
Come in, Lord William! and do ye in God's protection
stay."

Then William leaped into the boat, his terror was so
sore;
"Thou shalt have half my gold!" he cried. "Haste!—
haste to yonder shore!"
The boatman plied the oar; the boat went light along
the stream;—
Sudden Lord William heard a cry, like Edmund's
drowning scream!

The boatman paused; "Methought I heard a child's
distressful cry!"
"'Twas but the howling wind of night," Lord William
made reply;
"Haste!—haste!—ply swift and strong the oar; haste!
—haste across the stream!"
Again Lord William heard a cry, like Edmund's drowning
scream!
"I heard a child's distressful voice," the boatman said
again.
"Nay, hasten on!—the night is dark—and we should
search in vain!"
"And oh! Lord William, dost thou know how dreadful
'tis to scream!"

The shriek again was heard: it came more deep, more
piercing loud:
That instant o'er the flood the moon shone through a
broken cloud:
And near them they beheld a child—upon a crag he
stood—
A little crag, and all around was spread the rising flood.
The boatman plied the oar—the boat approached his
resting place—
The moonbeam shone upon the child—and shewed how
pale his face!
"Now, reach thine hand!" the boatman cried, "Lord
William, reach and save!"
The child stretched forth his little hands—to grasp the
hand he gave!
Then William shrieked; the hand he touched was cold,
and damp, and dead!
He felt young Edmund in his arms! a heavier weight
than lead!

"Oh, mercy! help!" Lord William cried, "the waters
o'er me flow!"
"No—to a child's expiring cries no mercy didst thou
shew!"
The boat sank down, the murderer sank, beneath the
avenging stream;
He rose, he shrieked—no human ear heard William's
drowning scream!

—*Southey.*

WATER IN A STATE OF VAPOUR.

WATER in a state of vapour constantly exists in the atmosphere. If the vapour comes in contact with anything cooler than itself, its moisture is at once precipitated. Around the cool sides of mountains frequently hang great clouds, which are only masses of floating vapour. The Scottish hills are celebrated for their mists, which are caused in the same way. The air of seaside towns is naturally impregnated with moisture, hence the mists which hang over some of them during certain months of the year.

The moisture from the atmosphere may be deposited in the form of dew, rain, snow or hail. Dew is formed at the surface of the earth; the heaviest deposits occur on the warmest nights. The night air, laden with moisture, comes in contact with the surfaces of plants, which have lost their heat by radiation, and which are therefore colder than the air: at once follows the deposition of moisture in the form of dew.

The form of rain may be originated either by the cool surface of the earth, or by cold strata of air existing in the higher regions of the atmosphere. Mountainous regions receive more rain than lowland districts, and maritime places more than inland towns. The rule is "that the annual rainfall decreases as you proceed from the coast to the interior of a country, and as you proceed from the Equator to the Poles." We, who live in the Temperate Zone, have more rainy days in the year than people who live in Tropical Regions, but they receive heavier rainfalls than we do.

We are so accustomed to see water in a sensible form, either fluid or solid, as in rain, ice, hail, snow, fog, and the like, that every one is surprised when he is made conscious for the first time, that water may really be found in the condition of a perfectly invisible vapour. Yet, whoever has seen a bottle brought out of a cellar on a warm day, or observed the effect produced when the windows of a carriage are drawn up, and particularly those persons wearing spectacles, the glasses of which are suddenly dimmed by steam upon entering a heated room, must have noticed enough to convince him that such is the case. In such instances the colder surface of the glass *condenses* the vapour of water, previously invisible in the atmosphere, and thereby renders it sensible. All the great changes of sunshine, cloud and storm, the various hues of the rising and setting sun, the haloes which occasionally surround the sun and moon are all influenced or occasioned by the vapour of water diffused throughout the atmosphere.

The vapour of water, however, in its simplest form is perfectly invisible. It exists mixed with the other gaseous matters which compose the atmosphere, and diffused over all parts of the earth's surface. Every substance which contains water, is capable also of permitting it to evaporate.

Not only large masses of water—as seas, lakes, and rivers, as well as ice—but every portion of vegetation, all soils, even those which appear driest, are continually permitting some portion of watery vapour to escape from them. The quantity of vapour in the atmosphere at any given time is influenced by a variety of causes; but the *presence* of such a vapour is most important for many purposes. Dew, which is formed by the condensation of the vapour of the water upon the leaves and other parts of plants affords nourishment to vegetation when no rain falls; and a certain quantity of vapour of water is essential to the health of man. In some hospitals when they were first warmed by heated air, it was found that the inmates suffered from their skin cracking and peeling off, as in very hot climates; but the inconvenience was immediately removed, when vessels of water were placed in several parts of the building, which by evaporation, supplied the requisite quantity of moisture to the air. The quantity of evaporation going on constantly is far greater than is usually conceived. In a hard frost, a lump of ice or snow will be observed sensibly to diminish, especially if a brisk wind is blowing over it. This is quite independent of the wasting of the frozen substance by thawing. In fact, snow or ice may totally disappear without any perceptible thaw, simply by evaporation. It has been computed from actual experiment, that an acre of snow evaporates *four thousand gallons* of water in twenty-four hours. All plants exhale vapour, and some much more than others. Thorn hedges exhale seven times as much as those of holly: and a cabbage perspires six or seven times as much as a man from the same quantity of surface.

There is, however, a limit to the power of evaporation, and this limit is fixed by the temperature of the climate, so that if, on the coldest day of winter, the air contains as much moisture as possible, or is, as it is called, *saturated* with vapour, it can then receive no more vapour unless its temperature is increased. But as the temperature of the air increases, more and more vapour may be mixed with it: yet still, as the heat of the air never exceeds a certain degree, the quantity of vapour also is limited.

Such a limitation is necessary for the well-being of all plants and animals: either a perfectly dry air, or an atmosphere overcharged with vapour, would be inconsistent with their existence in a state of health. As the atmosphere is now constituted, there is found in every part a certain quantity of vapour ready to make its presence sensible, whenever any change of circumstances causes it to be condensed.

One of the most common effects thus produced is that of clouds. The well-known experiment, mentioned above, of the condensation of vapour on a cold surface such as glass, shews that if the temperature of the air be by any means lowered, the quantity of moisture, which it will retain in the state of invisible vapour, will be diminished. In cold weather, this is made very evident by the condensation of the breath of animals. The air which comes from the lungs contains within it a quantity of watery vapour which would be quite invisible, if it were breathed out into an atmosphere of the same or nearly the same temperature, as that of the animal's body. But when the air is much colder, some of the vapour is instantly condensed, and forms very small drops. The same effect is seen on a large scale when steam is discharged from a steam-engine. Where, then, any change takes place in the temperature of the atmosphere, from any cause, there is a probability that the vapour in the atmosphere will be condensed and become visible.

Thus, suppose the air perfectly serene and clear, and that it contains in every part just as much vapour as it is then capable of containing; if a stream of colder air be now made to pass through a part of this atmosphere, the temperature of the two portions of air when united will be lower than that of the first portion was before, and the vapour in it will be partially condensed forming a cloud of greater or less density according to circumstances.

If the condensation goes on, the very small particles of water which float in the atmosphere—or, after descending a little way, meet with a warmer temperature, and are again turned into invisible vapour—will unite in drops of a sensible magnitude and fall in *rain.* Should they meet with a still greater degree of cold, the drops freeze in their descent, and appear as *hail;* or, if the congelation takes place while the particles of water are still very small, *snow* or *sleet* will be formed. By the same means all the different appearances of fog and mist are occasioned. During the heat of a summer's day, evaporation goes on with great rapidity, as has beer already noticed, from water, from all vegetable bodies, and even from the earth. But at sunset, heat begins to be lost by radiation, and some of the vapour is immediately perceptible, especially where evaporation has been most copious, as along a river or over meadows. The course of a river may sometimes be distinctly traced, for a long distance, even when the water itself is not visible, by the fine cloud formed by such congelation. On the other hand, when the atmosphere is charged with visible moisture, an increase of heat converts the water into invisible vapour. A very beautiful instance of this effect is often seen in Autumn. At sunrise the whole atmosphere appears full of floating particles of water, forming a dense mist, the minute drops of which are distinctly visible. As the sun rises above the horizon, the air is gradually warmed, the fog begins to disperse, at first rising a little into the form of clouds, but soon totally disappearing.—*Saturday Magazine.*

THE CLOUD.

I BRING fresh showers for the thirsting flowers,
From the sea and the streams;
I bear light shade for the leaves when laid
In their noonday dreams.
From my wings are shaken the dews that waken
The sweet birds every one,
When rocked to rest on their mother's breast
As she dances about the sun.
I wield the flail of the lashing hail,
And whiten the green plains under;
And then again I dissolve it in rain,
And laugh, as I pass, in thunder.

I sift the snow on the mountains below,
And their great pines groan aghast;
And all the night 'tis my pillow white,
While I sleep in the arms of the blast.
Sublime on the towers of my skyey bowers
Lightning, my pilot, sits;
In a cavern under, is fettered the thunder,
It struggles and howls at fits;
Over earth and ocean with gentle motion,
This pilot is guiding me,
Lured by the love of the genii that move
In the depths of the purple sea;
Over the rills, and the crags, and the hills,
Over the lakes and the plains,
Wherever he dream, under mountain or stream,
The spirit he loves, remains;
And I, all the while, bask in heaven's blue smile,
Whilst he is dissolving in rains.

The sanguine surprise, with his meteor eyes,
And his burning plumes outspread,
Leaps on the back of my sailing rack
When the morning star shines dead,

As on the jag of a mountain crag,
  Which an earthquake rocks and swings,
An eagle alit, one moment may sit
  In the light of its golden wings;
And when sunset may breathe from the lit sea beneath,
  Its ardours of rest and of love,
And the crimson pall of eve may fall
  From the depth of heaven above:
With wings folded I rest on mine airy nest,
  As still as a brooding dove.

That orbéd maiden with white fire laden,
  Whom mortals call the Moon,
Glides glimmering o'er my fleece-like floor,
  By the midnight breezes strewn;
And wherever the beat of her unseen feet,
  Which only the angels hear,
May have broken the woof of my tent's thin roof,
  The stars peep behind her and peer;
And I laugh to see them whirl and flee
  Like a swarm of golden bees.
When I widen the rent in my wind-built tent,
  Till the calm river, lakes, and seas,
Like strips of the sky fallen through me on high,
  Are each paved with the moon and these.

I bind the sun's throne with a burning zone,
  And the moon's with a girdle of pearl·
The volcanoes are dim, and the stars reel and swim,
  When the whirlwinds my banner unfurl.
From a cape to cape, with a bridge-like shape
  Over a torrent sea,
Sunbeam proof, I hang like a roof,
  The mountains its columns be,
The triumphal arch through which I march,
  With hurricane, fire, and snow
When the power of the air are chained to my chair,
  Is the million-coloured bow,
The sphere-fire above, its soft colours wove,
  While the moist earth was laughing below,

I am the daughter of the earth and water,
  And the nursling of the sky;
I pass through the pores of the ocean and shores;
  I change, but I cannot die;
For after the rain, when, with never a stain,
  The pavilion of heaven is bare,
And the winds and sunbeams, with their convex gleams,
  Build up the blue dome of air,
I silently laugh at my own cenotaph,
  And out of the caverns of rain,
Like a child from the womb, like a ghost from the tomb,
  I rise and upbuild it again.—*Shelley.*

MICHAEL ANGELO.

Lorenzo the Magnificent reigned over Florence. In his palace and gardens was a fine collection of antique marbles, busts, and statues, which the princely owner converted into an academy for the use of young artists. Michael Angelo was one of the first, who, having obtained the reluctant consent of his father, was received into this new academy. This was a great gratification to the youth. He had hitherto devoted himself chiefly to drawing, but the sight of the many splendid works of art in the Medicean gardens determined him to turn his attention to sculpture. He was then not quite sixteen.

Whatever Michael Angelo did, he tried to do well. With the fervour and the energy natural to his character, he now began first to model in clay, and then to copy in marble, some of the works of art before him. They were surprising productions for one so young.

Having found one day the statue of a laughing faun, considerably mutilated and without a head, the youthful artist resolved to try, if he could restore to it what was wanting. He succeeded admirably. Lorenzo, who often visited the gardens, was much struck with this display of genius, and inquired whose work it was.

"It is executed by one of the great painter's pupils," was the reply. "He and Granacci were the two he deemed most worthy of entering your academy, Signor. His name is Michael Angelo."

"I should like to see the youth," observed Lorenzo, who stood gazing at the statue; "there is great talent and genius here."

Michael Angelo was summoned.

"So, Angelo," said Lorenzo the Magnificent, "I perceive you have a taste for sculpture? That head does you credit."

Michael's dark eyes glittered. "It is a noble art!" he replied with enthusiasm. "By allowing me the honour of entering these gardens, excellent Signor, you have, as it were, raised a new spirit within me."

Lorenzo smiled. A great lover of the art of sculpture himself, he was pleased with the youth's evident devotion to it.

"Do you prefer it then to painting?" he asked.

"I do," replied Michael Angelo. "It is to me so much more wonderful and sublime."

"I see you have not exactly imitated the original in that head," observed Lorenzo; "the lips are smoother, and you have shewn the teeth. But," he added with a smile, "you should have remembered, Angelo, that old men seldom exhibit a complete set of teeth."

He passed on; and the young artist, who paid no less respect to the judgment than to the rank of Lorenzo, was no sooner left to himself, than he struck out one of the teeth, giving to the part the appearance of its having been lost by age.

On his next visit, Lorenzo, seeing this, and equally delighted with the disposition as with the genius of his young pupil, at once determined to take him under his especial patronage. "Angelo," he said, "your perseverance and improvement merit my regard. In order to give you every advantage, I am willing to receive you into my own service, undertake the entire care of your education, and bring you up in my palace as my son. What say you?"

What could Michael Angelo say to such a generous, flattering proposal! With heartfelt gratitude he thanked his noble patron, and then spoke of his father.

"I will see your father on the subject," said Lorenzo. "I trust he will not object to my wishes."

He sent for the old man, and gained his consent to the plan on condition, that he himself should receive an office under government. Accordingly, Michael Angelo was lodged in the palace of the Medici, where he remained for three years. He was ever treated with paternal kindness by Lorenzo, and had the advantage of associating with the first literary characters of the age.

But Michael Angelo, with all his genius, was not of a very amiable disposition. His temper was proud and haughty; his speech too often contemptuous and sarcastic. He felt his own great powers of mind, and too frequently indulged in satire towards those who were not so gifted as himself.

Lorenzo the Magnificent died, and Michael Angelo, thrown on his own resources, studied more diligently than ever. Secluded, temperate, and frugal in his habits, stern and unbending in his character, he suffered nothing to divert his mind from that on which it was set—his improvement in the art of sculpture.

About this time there was some sensation caused amongst the lovers of the fine arts in Rome, by the arrival in that city of a statue of extraordinary beauty. It was a Sleeping Cupid in marble; and great was the admiration bestowed upon it.

"It is a genuine antique," said one grave *connoisseur* in such things; "there is no mistaking it."

"Certainly not," observed another; "how infinitely superior it is to anything which art in this day is capable of producing!"

"It was found in a vineyard near Florence, I understand," said a third; "a peasant, while digging, came upon this exquisite proof of ancient skill and genius.

It is a pity the arm has been broken off. The Duchess of Mantua much desires it for her cabinet, I hear; but the Cardinal San Giorgio has already purchased it at a high price. He is charmed with its beauty."

"My friends," said a nobleman, as he entered the hall with hasty steps, "what do you think I have heard just now? that this 'real antique' which has so delighted us all, is the work of a young man of two-and-twenty, residing at Florence!"

The group round the statue actually started with surprise.

"Is it possible?" they exclaimed; "has one in our day executed this splendid work? It is marvellous! Are you sure you are not imposed upon?"

"Quite sure. The young sculptor has produced the missing arm, and given undoubted proofs of his veracity. The cardinal has invited him to Rome immediately."

"And what may be the name of this young man?"

"His name is Michael Angelo."

During his first residence in the imperial city, Michael Angelo, surrounded by so many beautiful remains of antiquity, applied to his studies with unceasing energy and increasing diligence. He executed several works, which added greatly to his reputation, particularly a group called the *Pietà*, which is now in the church of St. Peter's, at Rome.

A little time after the *Pietà* had been fixed in its place, the young artist went one afternoon to consider the effect of his work. As he stood before it, surveying it with a critical yet partial eye, and with a consciousness that he should yet do greater things than that, two strangers entered the church. Struck with admiration at the beautiful group presented to their view, they expressed, with Italian warmth and fervour, their great and unqualified approbation.

"What an exquisite work!" cried one. "Truly it is a masterpiece! What form! what proportion! what excellent grouping! I never saw anything to compare with it!"

"Wonderful!" said the other, after contemplating it for some time in silent admiration. "What a mind must the man have who executed this! Who is the sculptor?"

"One from Bologna; at this moment I remember not his name."

"Nay, my friend, I rather think he is a Florentine. Surely I have heard so."

"You are mistaken, Bernardino; I am convinced Bologna has the honour of being his birthplace; I shall bethink me of his name directly."

"Well, any one in Rome can tell us that, fortunately. There is a young man here will set us right, perhaps."

"Ah! let us not ask him; he might laugh at our ignorance, or he might not know himself. We will find it out. The name of that man ought never to be forgotten."

"It shall not be forgotten here, at all events," said Michael Angelo, as the strangers left the church; "the *Pietà* shall not be again mistaken for the work of the Bolognese."

That night, a young man of haughty bearing entered the church with a lantern in his hand. He approached the beautiful piece of sculpture, and smiled proudly, as in deep, indelible characters he inscribed on it, where it might best be seen—the name of Michael Angelo. This *Pietà* is the only one of his works thus inscribed.

Amongst the ruins of ancient Rome is a splendid equestrian statue of Marcus Aurelius. It is of bronze, and was originally gilt with thick leaves of gold. The attitude of the horse, and the fire and spirit displayed in it, are remarkably fine. When first Michael Angelo saw it, he looked at it for some time in silence, and then suddenly exclaimed, "Go on!"—thus stamping this famous statue with his enthusiastic admiration.

A very excellent painter lived at this time in Florence, whose name was Leonardo da Vinci. Italy was justly proud of this illustrious artist, and Francis I. of France loaded him with favours.

Slowly fading away from the wall of the refectory of the Church of Santa Maria, at Milan, is one of the most celebrated pictures of this great master. The subject is a solemn one—the Last Supper; and solemnly it is treated. The skilful arrangement of the figures, which are larger than life, and the amazing beauty of the workmanship, arrest the attention and astonish the eye of the beholder. It has thus been spoken of: "On viewing it, *one* head, one face, one attitude, one expression, comes forcibly upon the sight, and sinks deeply into the mind, till every thought and feeling is absorbed in wonder at the power which could represent so sublime a figure in so sublime a manner."

Leonardo da Vinci, like Michael Angelo, had astonishing powers of mind. He was great as a mathematician, a mechanic, an architect, a chemist, an engineer, a musician, a poet, and a painter! From a child his singular talents attracted notice; but he had not the perseverance of Michael Angelo. His magnificent designs and projects were seldom completed. He began many beautiful and wonderful works, and then, dissatisfied with them, left them unfinished. This highly-gifted man and Michael Angelo were rivals. With all their admiration of each other's genius, they were jealous of the distinction each had obtained. The haughty spirit of the one could not brook superiority, or even equality; the temper of the other was capricious and sensitive. Leonardo was many years older than Angelo, and did not feel pleased that so young a man should come forward as his competitor. One day, being annoyed at some remark made by his rival, he replied with warmth, "You will remember, Angelo, I was famous before you were born!"—*The Home Friend.—S. P. C. K.*

FAMILIAR ILLUSTRATIONS OF NATURAL PHENOMENA.—DEW.

THERE is scarcely a more beautiful sight in nature than that which is presented in a clear autumn morning, soon after sunrise. Every leaf and spray is united by the light tissue of the spider's web, on which are threaded beads of transparent water, glittering in the beams of the rising sun. Every blade of grass is, in like manner, enveloped in a fine coating of moisture, and spangled with brilliant drops. On an attentive observation, it will be found that the light, which passes through these minute globes of water, is separated into distinct colours. Spots of vivid red, yellow, and blue, will be perceived, scattered, apparently at random, over the glistening surface, and, in some favourable points of view, there may be traced upon the plain, an iris, composed of the same colours as the rainbow, and in the same order, but arranged in two branches receding from the eye.

The copious deposition of moisture, which produces this splendid spectacle, may have been occasioned by various causes. Fine *rain* may have fallen, or there may have been a sensible *mist*, or a thick *fog*. But, in many instances, the atmosphere will have appeared perfectly clear during the whole preceding night, and all the brilliant display will have been caused solely by the *dew*.

We propose to shew in what manner the dew is deposited. It is a very common error to suppose that the *dew* falls in the same manner as rain or mist, only in much finer particles. A very slight observation will shew that dew is not thus formed; for it is often deposited on the sides, and on the under parts of blades of grass and other substances, as well as on their upper surfaces.

Dew, in fact, does not *fall*, but is formed by the condensation of the moisture of the atmosphere. Every one is familiar with this phenomenon, though many may not have thought much about the cause of it. If we bring ` bottle from a cool cellar in the summer, a copious deposition of dew takes place upon its outer surface, If a sudden hail-storm drives against the windows, a dew is often deposited upon the inner surface. In these and the like instances, the surface exposed to the air is colder than the air itself, and since it is found that heat always passes from a hotter body to one that is colder, the invisible vapour of water in the atmosphere immediately in contact with the glass, loses part of the heat which is necessary in order to keep it in the state of vapour, and is condensed, or reduced to the form of water.

The moisture begins to be thus precipitated at a certain temperature, depending upon the quantity of vapour in the atmosphere. This temperature is called the *dew-point.*

But heat is given out from one body to another, not only when they are close together, but when they are at great distances from each other. Without at all attempting to shew what heat is, or how it is communicated from one body to another, it is sufficient for our present purpose to know, that there is a constant tendency in all bodies towards an equality of temperature; so that if there be two bodies heated to different degrees, the heat of that which is the hotter is given out, and increases the heat of the colder body. If the bodies are in contact, the heat is said to be communicated by *conduction;* if they are not in contact, the heat is said to be *radiated* from one body to another.

When, for instance, we are standing before a fire in a cold day, the heat of the fire is so much greater than that of the human body, that we are sensible of a great *radiation* of heat from the fire. But if a person comes suddenly into the room from the frosty atmosphere, we are sensible that he *strikes cold;* that is, that the heat given out by radiation from our bodies to his is greater than that which we receive in return.

By means of a delicate thermometer, the radiation of heat is very perceptible: and different bodies are found to radiate heat with greater or less readiness. Among those which radiate heat rapidly are glass, wool, the blades of grass, cotton, &c.

Hence, every object in nature is constantly radiating heat from its surface. If a body be surrounded by objects which are hotter than itself, it becomes heated by radiation: if it be exposed to the influence of objects which are colder than itself, it becomes cooled: and its temperature will not be sensibly altered, if the bodies around it have nearly the same temperature as itself. If, also, a body be formed of a substance which *conducts* heat badly, but *radiates* heat easily, the extremities of such a body, when exposed to other cooler bodies, will lose heat by *radiation* faster than it can be replaced by conduction, and will become colder than the other parts of the bodies.

Suppose, now, an extensive plain, partly covered with grass, and exposed to the atmosphere in a serene night. If the sky be overclouded, the heat radiated from all the objects in the plain, will be so nearly equal to that which is radiated from the clouds, that the surface of the plain will cool very slowly. But if the clouds clear away, the heat which is radiated from the plain, passes off into the open space of the heavens, and so little is radiated back, that the process of cooling goes on with great rapidity. In those parts of the plain which are covered with sand, or stone, or other substances which conduct heat well, the heat which is radiated from the surface, is speedily restored in part, by heat passing along the body from the interior, and the surface cools more slowly. But this is not the case with the blades of grass, or with any flocky substance, such as wool, cobwebs, and the like. These substances *radiate* heat rapidly, but *conduct* it badly. Hence, their surfaces become speedily cool, and as soon as they are cooled down to the temperature of the *dew-point*, the moisture of the air is condensed upon them, or there is a *dew.* If the radiation of heat still continues, the temperature of those surfaces may be still further lowered, even to the freezing-point; and then the deposition takes the beautiful form of *hoar-frost.*

In order, then, that dew may be deposited, the following circumstances must conspire:—

1. The sun must be absent, or, at least, must be very near the horizon.

2. The atmosphere must be nearly calm: whence the Spanish name of the dew is *serena,* indicating the serenity of the sky when it is most copiously deposited.

3. The sky must be free from clouds.

4. The substances on which the dew is deposited, must be freely exposed to the action of the sky, and must be of such a nature as to radiate heat easily and to conduct it with difficulty.—*Saturday Magazine.*

THE BRIGHTON AQUARIUM.

A VERY decided addition to the attractions of Brighton is furnished by the new Marine Aquarium, which was lately opened to the public after having been three years in process of construction.

On passing through the gates the visitor arrives at the top of a flight of granite steps, 20 feet in width, which lead to an entrance court 60 feet by 40 feet. The front elevation of the building, facing this court, is 18 feet high, and consists of fine brick arches with terra-cotta columns and enrichments. A frieze running round the court bears the inscription, "And God said, Let the waters bring forth abundantly the moving creature that hath life." On the north side of the court is a commodious restaurant, and on the south side, which abuts upon the new road, the wall is broken by niches containing vases. From the court, the entrance-hall, which measures 80 feet by 45 feet, is entered by three doors. To the south of this hall here is another entrance, with an inclined plane instead of steps, for the admission of wheeled chairs. On the north side are the retiring rooms, kitchen, and other offices; and on the east side is the entrance to No. 1 corridor of the Aquarium proper. This corridor, the longest of the three, is 220 feet long, and is broken by a central hall 55 feet by 44 feet. The roof, which is groined and constructed of variegated bricks, rests upon columns of Bath stone, polished serpentine marble, and Aberdeen granite, the capitals of the columns being carved in appropriate marine subjects. The floor is paved with coloured tiles arranged in a simple pattern. On either side are placed the first series of tanks, twenty-eight in number, varying from

55 feet by 30 feet to 20 feet by 11 feet 6 inches; the longest tank, which is upwards of 100 feet in length, being on the northern side of the central hall.

At the northern end is the Conservatory, 160 feet long by 40 feet wide, and 30 feet in height; the sides are covered with ornamental rock-work, set with ferns and other plants. At the extreme end of the Conservatory is a stream of water intended to illustrate the breeding of salmon and other fresh-water fish. On the southern side, running parallel with corridor No. 3, is a considerable space devoted to small table tanks.

From the southern end of corridor No. 2 runs No. 3 corridor. This corridor, which runs parallel with the Conservatory, is of the same length, and 27 feet wide; along its entire southern or seaward side is placed a line of tanks, intended for anemones and animals of that class, but at present containing store fish. Along that portion of the northern side not occupied by the table tanks are placed fresh-water tanks. At the end of this corridor, on the south side, there is a naturalist's room fitted with all necessary appliances; and on the north side there are the engines and pumps required for supplying the water, and for keeping it constantly aërated. The salt water is pumped direct from the sea into receiving tanks constructed under the floors of the corridors, and from these is conveyed into the smaller tanks and kept in circulation there by the same engine power. These tanks are capable of holding 500,000 gallons of water, and this quantity can be pumped from the sea in about ten hours. The same water can be used without renewal for an indefinite time; but it is absolutely necessary that it should be kept constantly supplied with air. In the open sea the air is perpetually renewed by the motion of the waves; but in a tank it would soon be exhausted by the respiration of the fish, unless there were ample provision for an artificial supply. This is effected by an air-pump, worked by steam power in the machine room, and connected with delivery pipes which descend nearly to the bottom of every tank, The general effect of the Aquarium is extremely pleasing. Each corridor bears some resemblance to a picture gallery, in which the glass fronts of the tanks represent framed pictures. The subdued light, the rich, sober, and harmonious colouring, the plash of the waterfall, the freshness of the fernery, and the endless variety and grace of movement of the finny captives, combined to produce a scene of beauty and attractiveness, which called forth the warmest expressions of admiration from all who saw it, and on which those who formed it may be most cordially congratulated.

When the tanks were first filled, great anxiety was occasioned by frequent breakages of the glass fronts. These are made of plate glass, about one inch in thickness, and 74 inches by 40 inches surface measurement. It was supposed that they would be strong enough to bear any pressure to which they could be subjected; but it was found in practice that they would now and then suddenly split in every direction, permitting the water to escape and the fish, if not speedily rescued, to perish. It soon became apparent that these breakages did not depend upon direct pressure, since they would sometimes commence near the top of a plate, where the pressure would be least. Many reasons were suggested in order to account for them, and, among others, it was supposed that the two surfaces of a plate might be unequally expanded from difference of temperature between the air on one side and the water on the other. Quite lately it has been determined to bed all new plates in India rubber, and up to this time none of those so treated have given way.

Two varieties of dog-fish are included in the collection. One kind, which is mottled with dark spots, is of nocturnal habits, and remains motionless during most of the day. One of the females has deposited two eggs in the tank; and these, as well as two eggs which have been brought in adhering to a piece of seaweed, will be watched with great interest. The other dog-fishes have no marking, and are in constant movement. The giant, whose untimely decease is mourned, belonged to the latter family. Gray mullet, Atherine smelts, gurnards in every variety of colour, lobsters, cray-fish, and spider-crabs comprise the most noteworthy of the remaining inhabitants, and in almost every tank there are hermit-crabs, to do duty as scavengers. The death of a small dog-fish afforded an opportunity of observing how well they discharge this duty; for it had scarcely reached the bottom of the tank when the crabs were seen moving towards it in all directions, and in an incredibly short space of time every morsel had disappeared before their united efforts. The lobsters have recently changed their skins, and are in the full glory of their most brilliant markings. Two of them seemed quite conscious of this fact, and spread out their beautiful blue and yellow tails against the glass for the inspection of visitors, while another walked sedately about, carrying his huge claws before him, and presenting a ludicrous resemblance to a child in its father's boots. In a neighbouring tank two spider-crabs, with heads erected, had placed themselves one on either side of an oyster in attitudes which seemed to convey scorn and defiance to each other; and a third spider-crab, who from the station he had taken up might have been desirous of seeing fair play, afforded a resting-place upon his shoulders to two hermit-crabs, who had climbed to that elevated position to obtain a better view. It is impossible to guess whether they were adequately rewarded for their trouble; for the preliminaries of the contest, or conference, or courtship, or whatever the affair might have been, were still unadjusted when it became necessary for spectators to withdraw.

In one of the tanks there is a party of hawksbill-turtles, five in number, and three of these are of considerable size. The Crystal Palace Aquarium has taught us with what perfect grace and elegance the turbot, sole, plaice, and other flat fish move through the water; and the turtle is fully worthy of the same commendation. He is seen to the greatest advantage when *descending, and at* the same time advancing *towards the spectator.* If advancing directly, his head and flappers rather ludicrously realize the conventional cherub, and suggest that an Aquarium must have existed at a very early period in the history of sacred art.

The oysters, apart from their important share in clearing the water, are usually unmoved spectators of the active life above them. Still, they resent liberties, and on Friday an alarm was raised by an attendant that "an oyster had collared the turtle." One of the flappers had intruded itself between the parted shells of the bivalve, and they had closed upon it with tenacious grip.

The fresh-water fish at present in the Aquarium are tench, goldfish, and chub, the latter bred and reared by Mr. Frank Buckland. That gentleman has also contributed an alligator—still a mere baby, but able to inflict a severe bite on one of the men who assisted in removing him from his travelling case.—*The Times.*

THE GREAT CURRENT OF THE ATLANTIC, CALLED THE GULF STREAM.

Persons are often prevented from inquiring into a subject, under the impression that it is too difficult for them to comprehend, when a very little attention would render it very easy.

Everybody, who has observed the stream rushing through a mill-dam into a wide basin of water, must have noticed, that a great part of the water is in constant circulation. If a chip of wood is thrown into the current, it is carried away at first very rapidly, but afterwards gets to the edge of the stream, takes a circuit, and is possibly brought back nearly to the place where it was first thrown in. This revolving motion of the water is thus occasioned: the water next to that in the stream is dragged along with it; the removal of this causes a hollow, into which the water next to it runs;

and this kind of motion is thus propagated throughout all the mill-pool.

Now this represents, on a small scale, a great natural phenomenon, called the Gulf Stream, because it was first observed in the Gulf of Florida, in the Atlantic Ocean. That particular current, however, is only part of an extensive circulation of all the waters in the great western basin.

To understand this, it must be observed that the waters of the open ocean, between the tropics, have a constant motion from east to west. This is seen very evidently at the Cape of Good Hope, where the waters of the great Indian Ocean unite with the Atlantic. There is a constant current setting from east to west, so that ships require a strong westerly wind to stem it: and many fatal accidents have happened by ships being driven upon the western coast of Africa, when they thought themselves many leagues to the east of it, from not allowing for the westerly current. The motion of the waters in the free ocean, would be at the rate of ten miles in the twenty-four hours, or about a quarter as fast as, upon an average, the principal rivers of Europe run.

Now, upon casting an eye upon the map of the Atlantic, it will be seen that this great stream of water, coming from the ocean round the south of the Cape of Good Hope, will run in about a north-westerly direction, until it comes upon the great dam formed by the coast of South America. The waters of the Atlantic, between the tropics, are themselves impelled by the same causes which create this current, and in the same direction. So that a vast body of water, arising from the united action of those currents, is heaped up against the shores of South America. The strength of this current falls upon that part of the coast which is to the north of the river Parabiba, and by the direction of the coast is sent on, in nearly a north-westerly direction, past the mouths of the great rivers, Amazon and Orinoco, where the waters of the current enter the Carribbean Sea. The island of Trinidad is placed here just in the heart of the stream.

and the waters pour between that island and the mainland with great rapidity, and then form a westerly current along the whole northern coast of South America. The effect of this current is seen in the distribution of land and water in that part of the globe. The islands of the West Indies seem to be those parts of a formerly connected Continent, which have strength enough to resist the continual force of the waves. And the Isthmus of Darien is, as it were, the backbone of a skeleton, of which the flesh and cartilages have been eaten away.

Along this isthmus the current of the western ocean is forced in a northerly direction; it meets with the turbid waves of the Mississippi, and proceeds to the southern extremity of Florida, so that its course is now turned nearly due east. Here it passes with great rapidity into the strait of Bahama, at the rate of *eighty miles in twenty-four hours,* or double the average rapidity of European rivers, and sometimes even with a velocity of *five miles an hour,* having now taken a nearly north-easterly direction.

We began by comparing the Gulf Stream to a mill-pool. To complete the resemblance at this point, we must suppose the stream which issues from the mill to be filled with *hot water;* for the great tropical current has been detained for a long time in the great hot gulf formed by the coast of Caraccas, the Mexican and Floridan coasts, and at length issues forth into the North Atlantic, at a temperature so greatly above the average heat of the ocean, that vessels navigating those seas, can tell within a few minutes the time of their entering the Gulf Stream by the sudden increase in the warmth of the water. This difference often amounts to nine, twelve, and fifteen degrees of Fahrenheit's thermometer, and sometimes to much more. Thus, on the banks of Newfoundland, the temperature of the cold water on the bank has been observed to be 50°, while that of *the stream was* 72°.

The breadth of the stream gradually increases after it leaves the straits of Bahama. Between Cape Biscaino and the bank of Bahama, the breadth is fifteen leagues. In latitude 28° 30′ N. the breadth is seventeen leagues. In latitude 41° 25′ N., longitude 67° W., it is eighty leagues wide; and having now met with a great arctic current, it is turned towards the east, at the southern extremity of the bank of Newfoundland, which Volney well denominates the *bar* at the mouth of this enormous marine river. The union of the *hot* current of water with the cold of the ocean and of the atmosphere is marked, at the bank of Newfoundland, by two phenomena. The current has expanded in width, and diminished in velocity. Hence, as in great floods, and at the mouths of rivers, the matter, which had been sustained in the water during its rapid motion, is now deposited, and in the course of years has formed the great bank of Newfoundland. Meanwhile, the water being relatively hot, the atmosphere which it brings with it contains copious vapours, which are precipitated, as soon as they meet with a colder current of air or water, and form those extraordinary banks *of fog*, which are, in the atmosphere of the bank of Newfoundland, what the bank itself is to the bottom of the ocean, a continual accumulation of matter brought from a distant region, to be there deposited.

The great current still continues onward to the east, and south-east to the Azores. At the westernmost of that group of islands it is a hundred and sixty leagues wide; and in latitude 33°, its southern edge is so near the northernly edge of the equinoxial current, running in the opposite direction, that a vessel cannot pass from one to the other in a day's sail. From the Azores, the current tends rather in a south-easterly direction, towards the straits of Gibraltar, the Madeiras, and the Canaries. It continues to set towards the African coast, between Capes Cantin and Bodojor. In latitude 25° 26′ the current sets *south*, is afterwards turned to the *south-west* by the trending of the coast by Cape Blanc, and soon after is again mixed with the equinoxial current, and proceeds to run again the same course.

Thus, between the parallels of 11° and 44° N. latitude, the waters of the Atlantic move in a perpetual round, as regularly as a mill-sluice: the waste being supplied by a constant influx of water from the Indian seas round the Cape of Good Hope. If a bottle were thrown into the sea it would return to the same point, unless retarded by accidental causes, in little less than three years, having completed a circuit of 3800 leagues, at the rate of rather more than ten miles a day. Such a bottle for instance, if sent adrift at the Canary Isles, would be floated to the coast of the Caraccas in thirteen months. Ten months more would take it round the Gulf of Mexico, and opposite the port of Havannah: and about forty or fifty *days* would then be sufficient to take it from the Gulf of Florida to the bank of Newfoundland: and perhaps ten or eleven months more would bring it to the coast of Africa.—*Saturday Magazine.*

CURIOSITIES OF PHYSICAL GEOGRAPHY.

THE depth of the ocean is very great in some places; for north of the Bermudas it was found to be nearly six miles. The pressure increases as we descend, and is so great that wood, which has been sunk to a considerable depth, has its pores penetrated with water to such a degree that it will no longer float. The ocean is darker than the darkest night in its lower regions; but in some part of the Arctic seas shells are clearly visible in four hundred and eighty feet of water; and in the West Indian seas the bottom is quite distinct at the same depth, the various hues of the submarine occupants of the ground being beautifully apparent. The true colour of the ocean is ultramarine, but every flitting cloud alters it, and organic and inorganic substances often tinge its waters: it is white in the Gulf of Guinea; black round the Maldives; vermillion off California; and so green in one place off the coast of Arabia that a ship has been seen to be in green water and blue at one time. Its saltness varies, the southern hemisphere being more salt than the northern; but the water of the lake of Eltonsk, east of the Volga, contains the greatest proportion of saline matter, and is thereby rendered the most buoyant water known. The Dead Sea is so saturated with salt that it irritates the skin, and towards the south, pillars of this substance project from beds of sandstone. The waters of the Caspian are becoming more saline and smaller in quantity, because more water is evaporated than is supplied to it, though it receives large rivers and has no outlet. This sea is subject to heavy winds, which drive the waters over the land; a vessel was thus washed forty-six miles inland, and there stranded.

The highest known waves are seen off the Cape of Good Hope in a north-west gale; their greatest height is probably about forty feet from the trough of the wave to its summit. The tremendous breakers on the west coast of Ireland occasionally rise one hundred and fifty feet, and the Bell Rock lighthouse, one hundred and twelve feet high, is actually enveloped in foam, when there is no wind, by the ground swell. A dry wind raises the sea more than a wet one; but in a gale the water is probably calm two hundred or three hundred feet below the surface. Vast currents occur in various parts of the ocean, and tropical seeds are brought by them in abundance to the coasts of Ireland and the Hebrides. In some parts of the Carribbean Sea it is said that a boat may be kept at rest on the surface of a sweeping current by lowering a heavy body down to some depth, where another current, running in an opposite direction, neutralizes the power of the upper one to drift the boat along. Winds and currents cause a necessarily circuitous voyage from Jamaica to the lesser Antilles to take nearly as many weeks as it takes days to return.

Could the Russians pass over the pole and through Behring Straits to their North American settlements, they would save a voyage of about twenty thousand miles. Icebergs drift into the Atlantic two thousand miles from their starting place in the Arctic seas, and cool the water perceptibly for thirty or forty miles around them, and the air much further. Ross met with multitudes in the South Polar seas with perpendicular sides, from one hundred to one hundred and eighty feet high, and some were several miles in circumference. The seasons are not supposed to influence the ocean to a greater depth than three hundred feet. In a course of experiments it was found that a sounding lead lowered to the depth of six hundred feet was so hot when raised that it could not be handled; this was probably owing to a submarine volcano or hot spring. The tide at Bristol sometimes rises fifty feet, and even reaches one hundred and twenty feet in the Bay of Fundy, in Nova Scotia, whilst there is scarcely any tide in the islands of the Pacific; up the Amazon it is perceptible for five hundred and seventy-six miles.

The famous Maelstrom, on the coast of Norway, is a mile and a half in diameter, and the roar of this whirlpool is so loud that it can be heard miles off. In the rocks of Cephalonia there is a cavity into which the Mediterranean has been flowing for ages.

The lakes of America contain more than one-half of the fresh water on the earth. The river Niagara unites two of these lakes, and forms the celebrated falls—the most sublime known. Lake Ontario and Lake Erie appear to be increasing in size; and in one of the bays of Lake Huron thunder is continually heard. A large lake of fresh water was formed in one night in Japan simultaneously with the uprising of a volcano from the earth. At the eastern end of Java there is a lake whose waters contain sulphuric acid, from which a river flows wherein no living creature is found, nor can fish live in the sea near its mouth.

A fall of one foot in 200 renders a river unnavigable. The Rhone, which flows very rapidly, falls one foot in 2,620, and has a velocity of 120 feet per minute. The Amazon, with its enormous mass of waters meeting the opposing tidal current from the ocean at a short distance from land, raises a terrific wave at spring tides, which carries devastation before it, shaking the very islands, it is asserted, in its passage. The Rio de la Plata is never less than one hundred and seventy miles across for two hundred miles from its mouth, and its muddy water discolours the Atlantic for two hundred miles. The swift and turbid Mississippi sweeps away whole forests when flooded, and the trees, heaped together in thick masses, are carried down and deposited at its mouth, and in the Mexican Gulf, over hundreds of square miles. These rafts are from six to ten feet thick, and often several miles in length. A stream which joins the Magdalena forms the cataract of Zequendama, where the river, rushing through a chasm, descends five hundred and thirty feet at two bounds into a dark pool, illumined only at noon by a few feeble rays, and sending up a cloud of vapour visible fifteen miles off. The rivers of equatorial America vary in colour; both white and black waters are found there. In boring artesian wells, which are often of great depth, the water frequently spouts up to the height of forty and fifty feet. There is a hot spring in South America which has a temperature of 206° 6′.

Next in order comes the earth—"the round world," which "cannot be moved." This immense globe, nearly twenty-five thousand miles in circumference, sweeps along in its orbit at the rate of more than eleven hundred miles in a minute, revolving in the same space of time upon its axis with a velocity which turns its equatorial inhabitants through more than seventeen miles. The intensity of gravitation varies from local causes as well as from the form of the earth; it is feeble at Bordeaux, and increases to Clermont, Ferraud, Milan, and Padua, this increase being probably caused by dense masses underground.

The earth is more than five times as heavy as a globe of water of the same size, and more than twice the weight of a similar globe of granite. There is a stratum of variable depth beneath the surface at which the temperature is always the same. The small portion of the earth through which man has penetrated—a mere atom of the distance to the centre—is arranged in layers called strata, in some of which the remains of animals and vegetables are found, converted often into stony matter.

Amongst these productions of bygone ages were tree ferns fifty feet in height; gigantic plants of the fox-tail tribe; shells shaped like a coiled-up snake and as large as a cart wheel; lizards, some with long swan-like necks, others with enormous eyes, and others with wings. There were also immense lizards, seventy feet in length and fourteen and a half feet in circumference, and huge mammals eighteen feet long with two tusks bent downwards, with which each is supposed to have raked up aquatic plants and to have anchored itself to the bank of the river or lake on whose waters it thus slept floating. Fossil remains are so numerous that with the exception of the metals and some of the primary rocks, every particle of matter on the surface of the globe has probably once formed a part of some living creature. Mountains are formed of minute shells; the tusks of fossil elephants have formed an article of trade for centuries, and whole islands in the Arctic regions are chiefly composed of the remains of such elephants. Coal—a collection of fossilized vegetable matter—occupies enormous spaces; the Appalachian coal-field in North America has an area of sixty-three thousand square miles, and that of Illinois, in the same country, is nearly as large as England. Could a person be raised above a point near Falmouth, until a whole hemisphere became visible, he would see the greatest quantity of land which can be beheld from any one place; and if raised above New Zealand, he would see the greatest quantity of water, so that England is nearly in the centre of the greatest mass of land. Nearly three-fourths of the surface of the globe is occupied by water.

Glaciers, a mixture of snow, ice, and water, move in the Alps at a rate of from twelve to twenty-five feet annually; but some there have not altered in shape or position from time immemorial, whilst others cover ground formerly cultivated. It is calculated that there are four hundred in the Alps alone, varying from three to fifteen miles in length and from one to two and a quarter miles in width; some of these have a thickness of six hundred feet. One pass across the Himalaya Mountains is twenty thousand feet above the sea, or more than fou. thousand feet higher than Mont Blanc The journey over the lofty passes in this range of mountains is terrific; many animals die from the rarity of the air; birds perish by thousands from the wind, and violent storms add to the horrors of the passage. In the dreary regions of North-Eastern Siberia, the people, and even the snow, both give forth a steam, and this vapour is instantly changed into millions of needles of ice, which make a noise in the air like torn satin. The raven in its flight leaves a long line of vapour behind, and the trunks of the thickest trees rend with a loud report. In the southern parts of these regions the glowing heat of summer produces a change like magic; the snow is scarcely gone when flowers of various hues blossom, seed, and die in a few months.

In the province of Cutch, in Hindostan, seven thousand square miles are alternately a sandy desert and an inland sea, for in April the wind drives the waters of the ocean over this tract of land, leaving bare a few grassy elevations on which wild asses feed. In the Andes there are cities, villages, and mines, at greater heights than the summit of what we consider lofty mountains: the highest city in the world is Potosì.

Immense plains are found in different parts of the earth, often nearly as level as the sea; there is frequently no eminence one foot high in two hundred and seventy square miles in the South American plains, some of which are covered with impenetrable thistles ten feet high others with grass mingled with brilliant flowers, where thousands of horses and cattle feed· others by swamps and bogs which are annually flooded for thousands of square miles, when multitudes of animals perish, so that in some places they give the ground the odour of musk;

others by thorny bushes and dwarf trees; others by dense impassable forests, in which myriads of animals live, filling the night air with one loud inharmonious roar, not continuously, but in bursts. Millions of animals occasionally perish on some of these plains, when their arid vegetation gets on fire from any cause. In North America, there is a tract of saline ground which is often covered to the depth of two or three inches with salt. In Canada, the trees with their branches are sometimes covered with ice an inch in thickness, whilst icicles hang from the boughs. The least wind brings them crashing down, and, should a breeze spring up, the forest at length gives way, tree after tree falls, carrying all before it, till the whole place resounds with terrific discharges like those of artillery. —*Home Friend, S.P.C.K.*

COMPOSED IN THE VALLEY NEAR DOVER ON THE DAY OF LANDING.

HERE, on our native soil, we breathe once more!
The cock that crows, the smoke that curls, that sound
Of bells,—those boys who in yon meadow ground
In white-sleev'd shirts are playing,—and the roar
Of the waves breaking on the chalky shore,—
All, all, are English. Oft have I looked round
With joy in Kent's green vales; but never found
Myself so satisfied in heart before.
Europe is yet in bonds: but let that pass—
Thought for another moment. Thou art free
My Country! and 'tis joy enough and pride
For one hour's perfect bliss, to tread the grass
Of England once again, and hear and see,
With such a dear Companion at my side.—*Wordsworth.*

FROM THE PLEASURES OF MEMORY.

TWILIGHT's soft dews steal o'er the village green,
With magic tints to harmonize the scene.
Stilled is the hum that through the hamlet broke,
When round the ruins of their ancient oak
The peasants flocked to hear the minstrel play,
And games and carols closed the busy day.
Her wheel at rest, the matron thrills no more
With treasured tales and legendary lore.
All, all are fled; yet still I linger here!
What secret charms this silent spot endear?
  Mark yon old mansion frowning through the trees,
Whose hollow turret woos the whistling breeze.
That casement, arched with ivy's brownest shade,
First to these eyes the light of Heaven conveyed.
The mouldering gateway strews the grass-grown court
Once the calm scene of many a simple sport,
When nature pleased, for life itself was new,
And the heart promised what the fancy drew.
Childhood's loved group revisits every scene,
The tangled wood-walk and the tufted green!
Indulgent memory wakes, and lo, they live!
Clothed with far softer hues than light can give.
Thou first, best friend that Heaven assigns below,
To sooth and sweeten all the cares we know;
Whose glad suggestions still each vain alarm,
What nature fades and life forgets to charm;
Thee would the muse invoke!—To thee belong
The sage's precept, and the poet's song.
When softened views thy magic glass reveals,
When o'er the landscape Time's meek twilight steals!
As when in ocean sinks the orb of day,
Long on the wave reflected lustres play;
Thy tempered gleams of happiness resigned,
Glance on the darkened mirror of the mind.
The school's lone porch, with reverend mosses gray,
Just tells the pensive pilgrims where it lay.
Mute is the bell that rang at peep of dawn,

Quickening my truant feet across the lawn:
Unheard the shout that rent the noontide air,
When the slow dial gave a pause to care.
Up springs, at every step, to claim a tear,
Some little friendship formed and cherished here;
And not the lightest leaf, but trembling teems
With golden visions and romantic dreams.
  Down by yon hazel copse, at evening, blazed
The gipsy's fagot—there we stood and gazed;
Gazed on her sunburnt face with silent awe,
Her tattered mantle and her hood of straw;
Her moving lips, her caldron brimming o'er;
The drowsy brood that on her back she bore,
Imps in the barn with mousing owlets bred,
From rifled roost at nightly revel fed;
Whose dark eyes flashed through locks of blackest shade,
When in the breeze the distant watch-dog brayed:
And heroes fled the sybil's muttered call,
Whose elfin prowess scaled the orchard wall.
As o'er my palm the silver piece she drew,
And traced the line of life with searching view,
How throbbed my fluttering pulse with hopes and fears,
To learn the colour of my future years!—*Samuel Rogers.*

CHANGES IN THE ATMOSPHERE.

There are several causes which tend constantly to produce changes in the atmosphere. We have already noticed, that the air which we breathe is composed of several different dry gases, that it also contains a great quantity of the vapour of water in an invisible state, besides the vapour which exists in the visible form of clouds and mists; and that currents of wind are always moving some parts of the air over the ocean, and others over large tracts of land, by which they become heated or cooled, and raise greater or less quantities of water by evaporation. Besides these causes there are others —for instance, the action of electricity, the effects of which upon the air are less known but very great. Thus we might expect from the combined action of all these causes, that the atmosphere should be in a state of constant change.

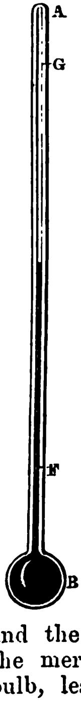
The real wonder is that, in a fluid so subtile as the air, yielding to every pressure, and expanding or contracting with every alteration of temperature, the changes of the air should be confined within such moderate limits as to be scarcely ever injurious.

The principal changes in the atmosphere are those which affect its heat, its weight, and its moisture.

The changes of heat are those of which we are the most sensible. But our own feelings give us a very imperfect measure of heat and cold. A simple experiment will shew this,—suppose a person puts one of his hands into snow, or into very cold water, and the other hand at the same time, into water as hot as he can bear it; and after suffering them to remain in that state for a few minutes, puts both his hands into water moderately warm, this water will convey a sensation of warmth to the hand which has been plunged into the snow, but will feel cold to the hand which has been in the hot water. As long, then, as we trust merely to our own sensations, we can have but a very uncertain estimate even of the sensible heat and cold of the air, or of any other substance. Much less can we estimate the sensible heat of bodies which part with their heat differently.

If a piece of wood, a piece of marble, and a piece of iron are all placed in a room heated to a temperature much higher than that of the human body, and the hand is then laid upon each, although each of these substances have the same actual temperature, the iron will feel the hottest, the marble not so hot, and the wood still less hot; and the reverse will be the case if each is first exposed to the action of a temperature much colder than that of the human frame. It becomes, then, highly desirable to have some instrument which shall measure exactly the changes of heat in the atmosphere, or in any other body. Such an instrument is called a thermometer, a word which implies heat-measurer.

THE THERMOMETER.



The principle upon which a thermometer is constructed is very simple. All fluids, when heated, swell out, so as to take up more room; and again shrink when they are cooled. Hence, if we can measure the quantity of expansion or contraction, we can measure the quantity of heat which has been added or taken away, provided that equal additions of heat always cause equal quantities of expansion.

Mercury (or quicksilver) is the most convenient fluid for this purpose; since, as far as can be ascertained, it does expand equally for all equal additions of heat, within the limits which it is required to measure. Suppose, then, a certain quantity of mercury to be put into a tube A B, having a very small uniform bore from A to B, and a bulb at the end B. While the end A remains open, let the mercury in the bulb B, be violently heated. The mercury will expand, so as to fill up the whole length of the tube, and drive out any air which is in it. When the mercury has reached A, the end of the tube at A must be closed by suddenly heating it by means of a blow-pipe. We have now the bulb and the tube filled with heated mercury. But as the mercury is left to cool, it shrinks back into the bulb, leaving a part of the tube towards A quite empty, except, indeed, that a very fine vapour of mercury still remains, the effects of which may not be neglected.

Now suppose the bulb of the thermometer to be plunged into melting ice, and that the mercury sinks to the point F. That point is called the freezing point of water, which gives one natural point from which temperature may be measured. Again, let water be made to boil, when the pressure of the air is in its mean state, or when the barometer (which we shall afterwards describe) stands at a certain height, and suppose the mercury in the tube of the thermometer then to have expanded as far as the point G. This gives us a second natural point for measuring temperature. The space between F and G may be divided into such a number of equal parts, as may be thought convenient. In Fahrenheit's thermometer, which is commonly used in England, the space between the freezing and boiling points of water is divided into 180 equal parts, the freezing point being 32 degrees, and the boiling point 212 degrees. In Réaumur's thermometer, the freezing point is 0, and the boiling point 80; in Celsius's thermometer, which is now most frequently used on the Continent, the freezing point is 0, and the boiling point 100. An easy rule reduces the degrees of one of these scales to either of the others;* but it would be a great convenience if all thermometers were constructed to the same scale. When a thermometer is graduated, or has its scale divided into equal parts, we have an accurate measure of the sensible heat of the atmosphere, or of any other body to which it can be applied; and thus we can know precisely what changes take place in the temperature of the air.

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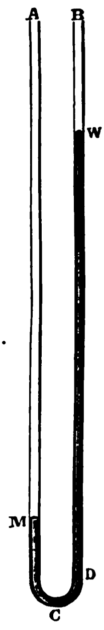
* To convert degrees of Réaumur into those of Fahrenheit, *above* freezing point, multiply by $2\frac{1}{4}$, and add 32; *below* freezing point, multiply by $2\frac{1}{4}$, and subtract from 32; thus,

$17 \text{ R} \times 2\frac{1}{4} = 38\frac{1}{4} + 32 = 70\frac{1}{4}$ F. of *heat*.
$8 \text{ R} \times 2\frac{1}{4} = 18$; 18 from $32 = 14$ F. of *cold*.

To convert degrees of Celsius into those of Fahrenheit, multiply by $1\frac{4}{5}$, and add 32, if *above* freezing point; subtract 32, if *below* freezing point.

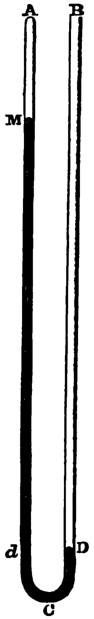
THE BAROMETER.



The changes in the weight of the air are also capable of being exactly measured, by an instrument constructed for that purpose—the barometer or weight-measurer. It can easily be shewn that the air has some weight; for if the air be pumped out of a copper ball, and the empty ball be then accurately weighed, there is found to be a sensible increase of weight as soon as the air is again admitted: the air being about 840 times lighter than the same bulk of water. If the weight of a given quantity of air could be accurately ascertained in this manner, at different times, a tolerably good measure of the change of weight might be obtained. But this change of air can be measured much more conveniently by taking advantage of a property of all fluids, of which air is one. If a bent tube, such as A B C, be partly filled with a fluid, and the tube be then held upright, with the part C, lowest, the fluid will stand at the same height in both branches. But if two different fluids, as mercury and water, one of which is bulk for bulk heavier than the other, be put in, the upper surfaces, M and W, will no longer be on the same level.

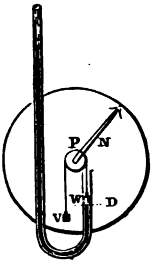
If D be the point where the two fluids join, the upper surface of the water, W, will be *fourteen times* as much above D, as the upper surface of the mercury, M, is; mercury being fourteen times heavier than water. And if a column, D W, of a lighter fluid than water be above D, the height of the mercury in the leg, C A, will be proportionally less, and if *air* were employed instead of water, no air being admitted above the mercury at M, the height of the mercury would only be about one 340th part as great as if a column of water of the same length were used.

Now, suppose the tube B C A, having the leg, A C, more than thirty-eight inches long, to be perfectly closed at A, and that mercury were gently poured in at B, and that means could be taken to shut out all the air from the part A C, and to fill that length of the bent tube entirely with mercury; if the tube were now set upright, the air being freely admitted at B, the upper surface of the mercury would be found to have settled at some point, M, at the height of about thirty inches above the line, D *d*, which is the level of the lower surface of the mercury on which the air rests at D. The pressure of the mercury above D *d* is therefore the exact measure of the pressure of air upon D, arising from the weight of the air in D B, and of all the air above B up to the top of the atmosphere: and if, from any causes the pressure of the air on D is increased or diminished, the change will be shewn in a corresponding rise or fall of the upper surface of the mercury at M.



Such an instrument would be a *barometer;* and if fitted with a scale at M, would shew by inspection the change of level of the surface of the mercury, allowance being made for the rise or fall also of the surface D. It will be observed that this explanation is not a description of the manner in which a barometer is practically constructed, but simply to shew familiarly the *principle* upon which it acts. The tube at D is generally much larger than the part A C, and sometimes the tube A C is straight, with its lower end plunged in a basin of mercury.

In some barometers a weight, W, rests on the surface, D, of the mercury, partly balanced by another weight, V, suspended by a string passing over a pulley, P. The axis of this pulley carries a pointer, N, which marks upon a dial-plate the rise or fall of the surface D, and consequently the change in the pressure of the air. The tubes and pulley are, of course, concealed from view by the case of the instrument.—*Saturday Magazine.*



MECHANICAL EFFECTS OF THE AIR.

Air is a great mechanical agent. While it remains at rest, it supports within it an innumerable quantity of birds and insects, which sport with the utmost freedom and ease. And when the air itself is put in motion, it becomes the instrument of most important and beneficial effects. The wind is constantly bringing a fresh supply of air to those places in which it is wanted. Currents of air are passing continually over the ocean, and thence are carried over tracts of land, and replace the heated atmosphere of the plains, and the unwholesome vapours arising from crowded cities. Meanwhile the breezes, which thus convey health and freshness with them, afford the means of navigating the ocean in various directions; the changes of the variable winds being such as to enable the sailor to pursue his voyage in almost any direction. In other parts of the earth, the wind blows regularly in nearly the same direction for a length of time; and thus becomes a certain means of conveyance.

On the surface of the *earth*, the wind is also constantly *doing work*. We can scarcely conceive the quantity of *labour* which is saved by that common but very beautiful *machine*, the *wind-mill*. How well it does its work!

How regular is its performance by means which appear so irregular! In different parts of the country we may see corn ground, timber sawed, marshes drained, water raised from great depths, and various other work done, and all by that invisible and apparently weak and inconstant agent *the wind.* The currents of air are thus strong enough to do us incalculable good; and very seldom, comparatively, are so violent as to occasion much injury.

The two great winds which blow from the Poles to the Equator, and from the Equator to the Poles are caused by the excessive heating of the air of Tropical regions. The air becomes heated, ascends, and flows off towards the Poles, while colder currents rush in from the Poles to supply its place.

If you examine a map of the winds, you will find that there are four great belts extending round the earth, and separated from each other by calm-belts. Those on either side of the Equator are called the north-east and south-east trade-winds; the remaining two are called the belts of variable winds.

The *trade winds* are so-named because they are so useful for trade purposes.* They consist of the currents of cold air which are making their way from the Poles to the Equator to supply the place of the heated air which blows over the tops of them towards the Poles. The belt separating the trade-winds is known as the Equatorial belt of calms, which calms are often varied by most violent storms.

The prevalent winds in the northern belt of variable winds are south-westerly ones, and the prevalent winds in the southern belt are north-westerly ones; these consist of the heated air which is making its way to the Poles.

If we followed a particle of air throughout its course, we should find that a regular circulation of air exists right round the globe. The particle after passing to the Equator, thence to the South Pole, and next to the

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* See *Standard V.*, p. 190.

Equator again, would eventually return to the North Pole from whence it started.

The *belts of winds* correspond with the *belts of rains.* The Equatorial calm-belt is the belt of constant precipitation, where rain falls nearly every day in the year. The trade-wind regions are the belts of periodical rains, where the year consists of two seasons, a wet and a dry. The belts of variable winds are the belts also of variable rains.

The most important regular winds next to "the trades" are the *monsoons.* These prevail off the coasts of India, the eastern coast of Africa, the northern coast of Australia, and small portions of the Mexican and Brazilian coasts. They blow for six months in one direction, and for six months exactly in the opposite direction, thus north of the Equator they blow north-east for six months, and south-west for six months. They are caused by the overheating of air over deserts and flat expanses of land; the north-east wind just mentioned would be the ordinary trade-wind, while the south-west wind blows during the hottest part of the year (the summer of these portions of the globe).

Many other winds exist. Land and sea breezes prevail in countries in the neighbourhood of the ocean. *Simoons* are hot winds that blow from the great desert of Sahara. *Etesian* winds are winds which prevail in the Mediterranean.

The distinctive character of certain winds is given to them by the nature of the part over which they have blown: thus an easterly wind to us in England is dry, cold, and piercing; in America it would be wet, and cool. In the former case the wind would have blown over land—Asia and Russia; in the latter case it would have blown over water—the Atlantic. A westerly wind with us partakes more of the nature of an easterly wind with the Americans, but it is much warmer since it has blown over the warm waters of the Gulf Stream.

Violent winds do great damage, and frequently accompany thunder-storms. These chiefly prevail in the warmest parts of the year, and are caused by the derangement of the electricity in the atmosphere. Forked lightning is seen when the storm is very near us. Sheet lightning is the reflection in the clouds of lightning caused by distant storms.

But the most dreadful of all storms are the hurricanes of tropical regions. They are known as hurricanes near the Island of Mauritius, as *tornadoes* in the West Indies, and as *typhoons* in the Japanese seas. These appear to be a combination of the hot winds from the Equator and the cold winds from the Poles. They possess a movement peculiar to themselves. The storm moves round a centre, and yet constantly advances. Its path most resembles a corkscrew. Fearful shipwrecks, great destruction of property, and submergences of land are the frequent accompaniments of these violent disturbances of the atmosphere.

The state of the atmosphere, the direction of the wind, the prevalence or non-prevalence of storms determine weather, and the result of a series of investigations with regard to weather decides the climate of a country.

Climate depends upon three circumstances, first, the position of the country on the earth's surface whether north or south of the Equator; second, its position with regard to neighbouring lands or seas; third, the direction of its prevalent winds. These three circumstances combine to give a country a good or a bad climate, thus England's position on the Temperate Zone gives her a Temperate climate, which is modified by the nature of the prevalent winds and her proximity to the Atlantic and its Gulf Stream.

THE TIDES.

PART I.

EVERYBODY knows how useful the tides are upon the sea coast. We constantly see a number of ships, all waiting at anchor for some hours, while the crews are able to take their rest. We keep looking at them, and, at a certain time, without any change of wind having taken place, we see them all busy setting their sails and weighing anchor, and, in a few hours more, they are all out of sight: they were, in fact, waiting *for the change of the tide.* If the wind was unfavourable, they could never make head against it, as long as the tide was against them too; but with the tide in their favour they can pursue their voyage, even against an unfavourable wind.

In rivers, the use of the tides is seen still more plainly. The tide brings not only a *current*, but a whole supply of *water* every twelve hours; and the continual change, which can be quite calculated upon, is just as useful as having a wind constantly fair up and down a river, alternately, for a certain number of hours every day.

Besides the immense importance of the tides to navigation, no one can calculate how conducive they are to health and cleanliness. Such a river as the Thames is thoroughly washed out, twice a day, by a current, carrying with it, towards the sea, all the drainage of a population of millions of people, and as often bringing up clear water and fresh air. It is a system of lungs, breathing regularly twice in about twenty-four hours.

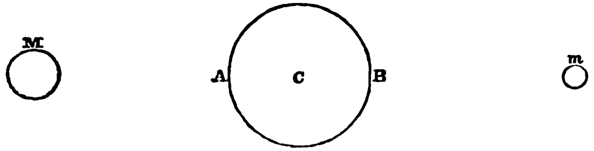
We shall endeavour to shew how the tides are produced.

It is soon seen that the tides are occasioned by the moon; for the time of high and low water comes back to the same hour whenever the moon is at the same age.

The *height* of the tide on different days plainly depends also upon the *age* of the moon. The highest tides are always found about the time of new and full moon, and the lowest when the moon is in her quarters.

What is to be explained then is, why the waters should rise and fall *twice* in rather more than twenty-four hours, and how this fluctuation is connected with the position of the moon. For this purpose, we will first see what the effect of the moon would be, if the whole earth were covered with water, and we shall afterwards easily discover what changes will be made, when we consider the actual condition of the globe made up of land and water.

Tides of an open Ocean.—It is well known that the moon is a solid body, which goes round the earth every month in a direction from west to east, and, from the real motion of the earth on its axis, *appears* to move round from east to west every day. Supposing, then, M to be the moon, and C the centre of the earth, there is some point, A, upon the surface of the earth, which is nearest to the moon, and another point, B, exactly opposite, which is furthest from the moon. Now every solid body, such as the moon, is found to *draw towards it* any other body, by a force which is called *gravitation*, and is really the same force by which a stone falls to the ground; and this force is the *greater* the *nearer* the attracted body is to that which attracts; thus A would be attracted by M more than C is, and C would be more attracted by M than B is. If these three particles, A, C, and B, were quite at liberty to move towards M at the end of any time (as a minute), A would have moved towards M through a greater space than C had, and C through a greater space than B had; hence A would be further from C, and C further from B, than each was at first. And if the motion of B be regarded only with reference to the point C, *considered as at rest*, the effect would be the same as if it were really drawn *away* from C, by the attraction of some other body (*m*) exactly opposite to M.*



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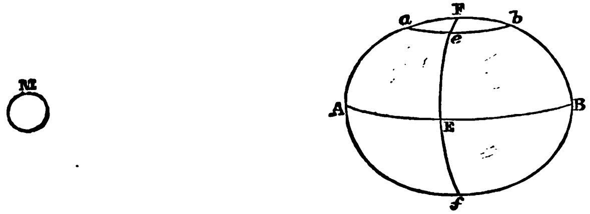
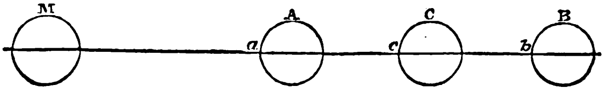
* It may appear somewhat strange to those who have not thought before about the matter, that an attraction towards M should cause a rise of the waters in the part *opposite* to M, and it may be worth while to explain the principle upon which it depends a little more clearly. Suppose, then, A C B to be three equal small balls of iron, floating on pieces of cork, and one foot asunder; then suppose a powerful magnet to be applied at M, which draws A through three inches, C through two inches, and

If, then, A C B were a sphere of *water*, a particle at A or at B would be lifted a little above its ordinary level, reckoned from C, and all the water near A and B would also be lifted, but in a less degree; hence the form of the globe would be altered; it would no longer be a perfect sphere, but would take an egg-like shape, the two little ends pointing towards M, and in the opposite direction—that is, there would be *a high water* at A and B; but at such a point as E, in the circumference A E B, (half-way between A and B,) the height of the water would certainly not be raised by the attraction of M, and it can be readily shewn, that it would be rather lowered, and there would be there *a low water.*



Now, suppose this watery globe to turn round upon an axis F *f*, at right angles to the plane B E A, it is plain that, for any place in the circumference B E A, there would be two *high waters* in each revolution; one when it comes to A the other at B; and two *low waters,* one at E, the other at a point exactly opposite to E.

B through one inch; if the bodies be then stopped, as at *a c b*, it is plain that the distance of *a* from *c* is now one foot two inches, and the distance of *b* from *c* is one foot one inch, instead of one foot. The effect, therefore, of the attraction of M has been to *separate* the two bodies, B and C, as well as A and C.



For every point, as *a*, on the globe, between A and F, there would also be a high and low water twice in every revolution, but not *so* high nor *so* low, as for a point in the circumference A E B, in the plane of which M lies.

If the earth, then, were a globe of water, there would be a high water nearly at the same time of the moon's southing, or coming to the meridian of any place, and a low water at about six hours after that time. Since the moon, in consequence of its own motion round the earth, comes to the meridian of a place about forty minutes later every day, the *times* of high water would also be so much later.

Such are the sort of tides which would take place upon a globe totally covered with water. But we shall see what changes are introduced in the tides, upon a globe which has a surface partly of land and partly of water.

PART II.

On the Tides of Narrow Seas.—We have already seen that, if the earth were a sphere entirely covered with water, the attraction of the moon would cause a rise and fall of the water upon its surface, twice in the course of rather more than twenty-four hours. The waters of an open ocean would be heaped up in the parts under the moon, and in the parts which are exactly opposite, on the other side of the earth. And this great wave would constantly follow the apparent course of the moon. It would be of immense *breadth*; for there would be only two ridges and two hollows in the whole circumference of the earth, which is about twenty-four thousand miles at the Equator.

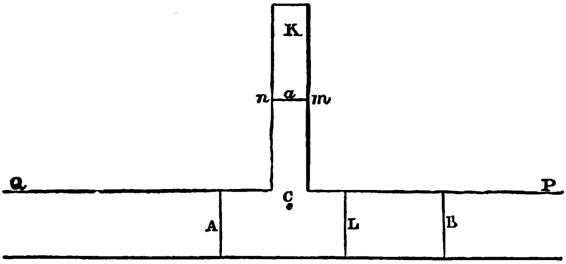
But if we only look at an artificial terrestrial globe, or at a map of the world, we shall see at once that *such* a tide can never take place; for the land everywhere interferes with the sea, and the depth of the sea itself, although great, according to our notion of distance, is very small compared with the whole bulk of the earth. The greatest height of any mountain above the level of the sea is about five miles, and it is probable that the greatest depth of the sea is not much more. Now the earth is a globe, the diameter of which is sixteen hundred times as great as this, so that the utmost depth of the sea, on an artificial globe sixteen inches in diameter, would be represented by a thin fibre only a hundredth part of an inch thick, or about as thick as the paper on which this is printed.

Still, wherever there is an ocean of considerable extent, *measuring from east to west*, there will be found a tide-wave on the same principles as we have already supposed, the ridge of which follows the apparent course of the moon from east to west. Now, the only part of the sea in which the action of the moon upon the waters can cause anything like such a regular tide is the Great Southern ocean, including the southern part of the Atlantic and Pacific Oceans, and of the Indian Sea. Although this great belt of water does not lie under the Equator, it extends with little interruption, in a direction from east to west, round the whole of the globe. In these seas, then, we may look for a tide of great regularity; and it is accordingly found.

The sea next in extent, in a direction from east to west, is the remaining part of the Pacific Ocean.

With respect to the Atlantic Ocean, although it extends nearly from Pole to Pole, in a direction from north to south, its breadth from east to west is by no means so great; and for the present purpose we may consider it as a great arm of the Southern Ocean, stretching in a direction at right angles to the course of the general tide-wave in that open sea.

To understand how the tides in such an arm of the sea are formed, let us suppose a long trough, P Q, and a narrower trough, C K, opening into it. Now, suppose the water in P Q to be set in motion so as to have a succession of waves passing along from P to Q, and suppose A and B to be two successive *ridges* of such waves, with a *hollow* between them at L. Then, when the ridge A is at C, the water will be highest at C; as the ridge moves along, the water at C will sink, and be the lowest when L reaches C; and it will again rise until the second ridge B has reached C.



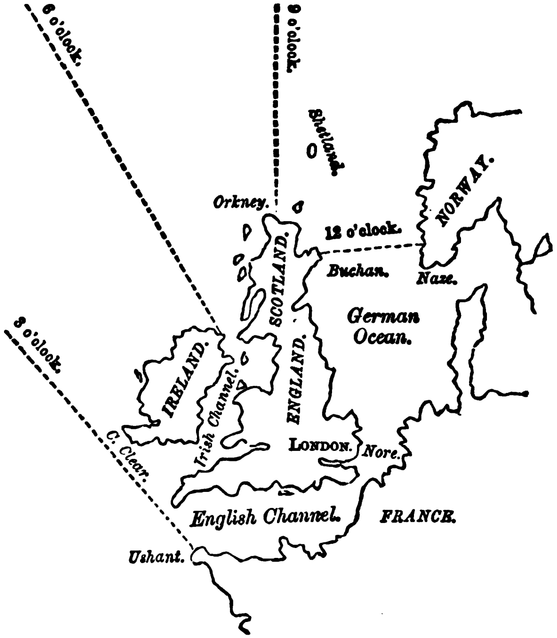
But it is plain that since there is nothing to stop some of the water of the ridge A from running along the trough C K, to find its level, part of it will run along and form a movable *ridge* (*a*), which will advance along C K exactly in the same manner as A moves along P Q. There will therefore be a *new set of waves* moving along C K, *not* in the direction of the *width* of C K, but in the direction of its length.

It must also be observed that the ridge (*a*) may not move so fast as the original ridge A, but that the *time* elapsed between the passage of two successive ridges past any point (as *m*, in C K) will be the same as the time between the passage of two successive ridges, A B, past C; since the ridge B would give rise to a wave under the very same circumstances as those in which A caused one.

Now we may conceive P Q to represent the Great Southern Ocean, along which the *tide-wave* is constantly passing, in the direction P Q, from east to west. In like manner, C K may represent the Atlantic Ocean, of which *m* is on the African coast, and *n* on the American coast. And we shall have a succession of *tide-waves*, such as (*a*,) moving from *south to north*, and succeeding one another, after the same interval of *time*, as that in which A succeeds B, or a little more than twelve hours.

Accordingly, it is found that, in the Atlantic Ocean, the tide-wave does move from south to north, the ridge of the waves extending in a slanting direction, and in an irregular form, across from the African to the American coast.

In order to explain the manner in which these waves cause the tide in different branches of the same sea, we will trace the course of the tide-wave round the coast of England.



Suppose the moon to have passed the meridian of Ushant, on the north-west part of the coast of France, at twelve o'clock in the day, the tide-wave of the Atlantic will reach Ushant soon after three o'clock on the same afternoon, its ridge stretching towards the north-west, so as to fall a little south of Cape Clear, in Ireland.

This wave soon after divides itself into three branches.

One part passes eastward up the English Channel, causing high-water in succession at all the places at which it arrives. It moves at about the rate of fifty miles an hour, so as to pass through the straits of Dover and reach the Nore about twelve o'clock at night. The second branch of the tide-wave passes more slowly up the Irish Channel, causing high-water along the coast of Wales, Lancashire, and Cumberland, and upon the eastern coast of Ireland. The third and principal part of the same wave moves more rapidly, being in a more open sea. By six o'clock it has reached the northern extremity of Ireland: about nine o'clock it has got to the Orkney Islands, and forms a wave extending *due north.* At twelve o'clock at night, the summit of the same wave extends from the coast of Buchan in Scotland, eastward to the Naze in Norway, and in twelve hours more it has flowed down the eastern coast of England, forming the *flood-tide* from the north, and reached the Nore, where it meets the morning tide which left the mouth of the English Channel above eight hours before.

The consequence of the meeting of the two tides at the Nore is very remarkable in the Thames. Sometimes the tide from the north is a little later than the other, and continues to flow after the other has ebbed considerably, thus causing a *second* tide on the same day. Another consequence is that, on the whole eastern coast of England, the tides are upon the whole highest when the wind blows strongly from the north-west, or off shore. This may appear strange at first, but the cause is quite plain when we remember that the tide is caused by such a wave as has been described, passing round the northern extremity of Scotland into the German Ocean.

It will be seen also that the tide in the English Channel is twelve hours *earlier* than the tide in the German Ocean: so that if the highest spring-tide from the *south* reached the Nore at twelve o'clock in the *day,* the highest spring-tide from the *north* would not occur till twelve o'clock at *night.—S. M.*

LESSONS IN GEOLOGY.

AROUND each village or town various soils are found; sometimes they resemble one another; sometimes they do not; sometimes expanses of chalk prevail; sometimes tracts of gravel; sometimes granite abounds; sometimes sandstone. Geology is the science which explains the differences between these various soils. It takes into consideration the structure of the entire earth, analyzes that structure, arranges its various parts, and seeks to explain the origin of those parts, and the reason of their present arrangement. But Geology has practical as well as theoretical uses; and the former render its study important and necessary to the miner, the railway constructor, the architect, and the builder.

The means of practically studying this science exist within the reach of all. A heap of stones by the roadside unfolds to one acquainted with Geology the history of past ages. Every quarry, every railway cutting, every river-bank, every sea-side cliff, every well sunk, all shew the successive stages through which the earth has passed previous to attaining its present state and condition.

The geologist explains the earth's past history by means of the present operations of nature. He sees layer of earth overlying layer of earth, and he knows, from observation, that those layers have received their present position from being deposited by water. He observes how some rocks appear twisted and distorted, and he explains it by the pressure, both lateral and perpendicular, of older and harder rocks. He watches the effect of the atmosphere upon rocks, and thus accounts for their wasted appearance, and for the immense boulders precipitated from rock-summits to the valleys beneath. He stands by the river-side, and notices that the banks are gradually being washed away. He observes the mud that discolours the waters, and by its means he can account for the delta that the river forms at its mouth. He travels into distant lands, and the violent action which accompanies the eruptions of volcanoes, explains to him how some rocks are "on edge," some "inclined" to each other, and some resting at right angles upon others. Again he visits the sea-side, and he sees that the incessant action of the waves upon the coast originates the numerous hollows and caverns that there abound. All these are operations of nature, which are going on during every moment of the day; they can be watched by any of us, if we will only use the eyes and the understanding that God has given us. And by these operations all geological facts can be explained.

By the term "earth's crust" is meant "that portion of the earth's surface which comes within human research." It is of small extent, compared with the entire thickness of the earth. But still the information thus gained is of the most interesting and most useful nature. Unaided by the geologist, gold mines could only accidentally be found, and none would know where to seek for coal. Unassisted by the geologist, the builder would not know where to find suitable stone, while to the researches of geologists the engineer owes much of the success that attends his undertakings.

The atmosphere, by means of the gases of which it is composed, greatly influences the rocks composing the earth's crust. The two gases most instrumental in these changes are *oxygen* and *carbonic acid*, the latter acts upon those containing lime, the former upon those containing iron. Stand at the foot of any great rock, and you will easily trace the results of atmospheric influence upon it. See its top shaped most grotesquely, here forming a natural grotto, there forming a curiously-shaped castle, here with sharp points shooting heavenwards, there with peaks whose sides are completely jagged and broken. Again look at the foot of the rock, and you will notice directly the broken fragments of the rock itself, the portions which have been detached by the wearing influence of the atmosphere and which now lie carelessly strewn along its base.

Low plains also suffer from atmospheric influences. Across deserts blow violent winds, which increase in intensity as they proceed, and which carry with them the sand of the desert. Ofttimes the sand thus carried away brings destruction of crops and future barrenness of soil to the fertile lands that bound the desert. Frost splits rocks and loosens the surface soil.

Both fresh and salt water effect changes. The river pursues its course heavily laden with sand, mud, and gravel, and these burdens it deposits at its mouth, and thus forms a delta. The waves of the ocean dashing against a rock-bound coast, slowly, but gradually and surely, wear away the coast, and wash away the softer portions of the rocks. The English coast from Yorkshire to Kent has suffered in this way during the last eight hundred years. The Goodwin Sands once formed the estate of Earl Goodwin, the powerful opponent of Norman influence at Edward the Confessor's Court. Ravenspur, the place where both Henry IV. and Edward IV. landed on the Yorkshire coast, has disappeared, and its exact locality is not known.

Volcanoes, earthquakes, and, alterations of level, are the manifestations of the force of the fire in the earth's centre. These forces are compensating agents; the action of the atmosphere and water would speedily degrade the earth, they would quickly lessen the surface in the ways that have just been described, but the volcanic forces raise up again the parts that have fallen, so that although individual parts of the earth may from year to year suffer change, yet the entire area of the land above the water's surface always remains the same. The alterations of level of various parts are remarkable. Upon the tops of the highest mountains are found marine shells, the proof that once those mountains formed a portion of the ocean's bed. In the high plains which exist in many of the continents at immense distances from the sea, there the same proof exists, and their surfaces are covered with sea sand, and shells. The alterations take place very gradually ; years elapse before any remarkable height is attained, but at length the wonderful working of these forces is seen. The coast of South America continues to rise in this manner, The island of Greenland is gradually sinking, while the shores of the Baltic are rising.

All classes of life, both plants and animals, contribute to effect changes. Vegetation constantly adds to the soil. Leaves fall, decay, and become changed into "leaf-mould." Large forests become submerged, and change after the lapse of many centuries into beds of coal. The excretions of animals continually produce changes. Some living creatures spend the period of their existence in increasing the amount of evil possessed by the earth. The little coral insects congregate together in thousands, they elaborate lime from the sea-water, and build therewith the numerous coral islands which stud the ocean. Sponges, &c., elaborate silex or flint from the water, and form at the bottom of the ocean huge beds of flint similar to those that distinguish past ages.

THE VARIETIES OF ROCKS.

Careful study of portions of the earth's surface situated in all parts of the globe, has resulted in the conclusion that all kinds of rocks may be arranged in two great groups. These two groups are, the *stratified* and the *unstratified;* the former arranged, the latter disarranged; the former shewing conclusively the manner in which they were formed, the latter consisting of all kinds of matter, the method of whose formation can only be conjectured. Between these two great groups there is an intermediate series. It possesses neither the confusion of particles which distinguishes the unstratified rocks, nor the traces of life which characterize each of the stratified systems. The series partially belongs to the one set of rocks, and partially to the other. Hence the name applied to these rocks of *transitional.*

The *unstratified* rocks form the base upon which all the other rock systems rest; they are "the foundations of the earth." They have been formed by the agency of fire. The *unstratified* frequently appear associated with the stratified: either they have upheaved the stratified, broken them, or become intermixed with them. Granite is the most ancient, lava the most modern, of this group of rocks.

The transition rocks occur in beds horizontally arranged. This would shew, that originally their particles were deposited by water. But, besides this, they possess no single trace of their origin and history. No fossil forms are found within them. Some explain their present appearance by stating that it is the pressure they have sustained from overlying rocks that has so materially altered them, and they assert that if a sufficient time were allowed to elapse, and the pressure allowed to continue, the transition rocks would assume the appearance of granite.

The stratified rocks extend over a vast area of the earth's surface. Were they all placed one upon another, we should never be able to discover the numerous classes into which geologists have divided them. But in few parts of the world are the stratified systems, as a whole, arranged horizontally. In nearly every country, volcanic forces have been at work, here lifting up, there breaking them asunder. It is the apparently unnatural positions assumed by strata, when influenced by these forces, that enables us to learn the relative positions of the various systems. By crossing England and Wales, from Kent on the one side to the Welsh coast on the other, we should pass over all the geological systems. England, in this matter, possesses a great advantage over other countries. The volcanic forces have been working with such force in past ages beneath our country, that all the strata have lost their horizontal position, and have become set "on edge:" by this term geologists mean tilted up. From this circumstance England derives such varieties of soil and such valuable mines. The edge of a stratum, that part which lies along the surface, is called its *outcrop*, and the line of outcrop forms the *strike*. The manner in which a stratum is inclined to the horizon is called its *dip*. The angle of the dip may be measured by holding one of your hands upright, and then placing the other hand at right angles to it. When we walk along the upturned part of a stratum, we follow the strike; when we dig, following the stratum, we are guided by the dip.

Four circumstances distinguish the stratified systems, and by these four circumstances the relative age of each can be ascertained. These are,—*position, mineral constituents, imbedded contents,* and the *traces of life.*

Position is very important. If one rock is found to underlie another, the necessary deduction is, that the lower rock is older than the upper. The Ganges and the Nile wash down to their mouths tons of matter daily; but the layers at the bottom will always be older than those at the top. Hence, if coal-containing strata be found beneath beds of red-sand, we at once conjecture that the former are of a greater age than the latter. The slates of Wales underlie the sandstones of Devonshire; the sandstones of Devonshire underlie the coal formations of Northern England; and the chalk-beds of Kent underlie the clay and sands of London.

The true means of ascertaining a rock's age are the *traces of life* it possesses. Each system has a distinctive form of life, and those forms still exist as "fossils." Fossils are petrified remains of once living beings; the word means anything dug up: but it is advisable to restrict its meaning. Dr. Page, in his Geology, thus describes an ordinary process of fossilization:—"A shell, like the common cockle, may be buried in a mass of mud, and when so enclosed, it is of itself composed of carbonate of lime and a little animal matter. As it remains imbedded, chemical changes take place,—the animal matter decomposes and passes off in gas, and its place is supplied by an additional deposit of lime from the mass. As the mass becomes consolidated into limestone rock, the shell will also become hard and stony, but still preserving its form to the minutest ridge of its surface. By-and-bye, carbonated waters may filter through the pores of the limestone; the shell may be dissolved entirely, and leave only a hollow cast of its form. Another charge may now take place; water holding flinty matter may run through the rock, and the hollow shell-cast be filled entirely with flint. All these are possible changes, and changes that every day present themselves to the eye of one who studies the forms of ancient life.

FIRE-FORMED ROCKS.

The fire-formed rocks form a class distinguished from all other systems by their not possessing fossils, and the evidence they possess of their origin by the agency of fire. Little is known of the earth's interior, but much has been conjectured, and for many years the majority of geologists have held the opinion that matter in a state of liquid fire forms the earth's centre. This internal fire was originally derived from the earth itself. In that far-distant "beginning," before the present state of the earth came into existence at the fiat of the Almighty Creator, the earth was a revolving globe of fire, which had been a portion of the sun, but was afterwards detached from that body. As this fiery globe cooled, a solid crust was formed, and age by age the crust has increased in thickness. At times, however, the fire makes its presence known, and bursts forth through the earth's safety-valves—the volcanoes.

Granite is found in all quarters of the globe. It underlies all rocks. It forms the base upon which all the others rest. Granite differs from granite, even as one stratified system differs from another. The name is a general one.

Space does not allow more to be said about these important rocks, but their value will be appreciated when it is mentioned that they are the chief depositories of the world's mineral wealth, and that all the great mountain-ranges are mainly composed of granite.

Volcanic Rocks are the formation of recent times. They occur in the vicinity of volcanoes. The molten matter that pours forth "from the bowels of the earth," assumes different appearances in accordance with its rate of cooling. Tons and tons of lava pursue their course down the sides of Vesuvius during an eruption.

Lava, after cooling, much resembles the slag from a furnace. The solidified froth or scum forms pumice, a light-coloured, spongy-looking substance, useful for polishing purposes. Both soft porous earths, and dark close-grained rocks have been formed with molten lava. The ancients obtained a peculiar glass-like substance from lava; they called it obsidian, and used pieces of it as looking-glasses.

To enumerate the mercantile products obtained from the fire-formed rocks, would be to enumerate every mineral product that is valuable for commercial purposes. From Sicily and Italy we obtain our chief supplies of sulphur and borax. Granite rocks supply us with the best building and road-making material.

METAMORPHIC ROCKS.

Pressure, as we all know, produces rapid changes in any substance which comes under its influence. Place a heavy weight upon clay or sand, and watch the results. The pressure developes heat, the augmented heat produces change.

The finest marble for making statues is that from Carrara, in Northern Italy. There for centuries has this wonderful stone been quarried. In the time of Julius Cæsar it had obtained renown, and still sculptors use it in preference to all other varieties. Carrara marble has a beautiful white colour, and is perfectly pure, except where crossed by gray veins.

This splendid marble is only ordinary consolidated lime, whose particles have become changed in form by their subjection to heat. Whence came that heat? Was it heat communicated from the earth's interior, or was it heat developed by pressure?

Once men thought these splendid marbles formed portions of the original matter of the earth. They asserted that these changes were effected before the creation of living beings. But careful examination of the localities where they occur does not warrant this supposition. It shews, on the contrary, that they were originally limestone belonging to the later system. Hence the present condition of the limestone was obtained during one of the last ages of the earth's history.

The Carrara marble rests upon beds of talc-schist and mica-schist. But these schists are only rocks that have been subjected to change.

Thus, this series which many deemed so old, consists of ordinary stratified rocks, which have changed in appearance.

FOSSILS.

Fossils are the guides by whose aid alone the true classification of rocks can be learned. Without them, we are completely "at sea," for the mineral structures of the various strata so resemble each other that we could not really, by their help alone, arrange the strata into the various systems. Fossils are the keys which enable us to unlock the doors of geology, and to discover the great truths which were concealed from human knowledge by man's own want of research for such a vast number of ages.

The word "fossil" is derived from a Latin word, which signifies "dug up." It is applied to any vegetable or animal substance that has become wholly or partially petrified. Now, we wish to see what kinds of beings are found in this state,—what were the great types of life that existed in those first ages of our earth's history.

The earliest forms of life detected in rock-masses are of the lowest class. The tracks of worms, the borings through sand, and the traces of heavy falls of rain, are the first signs that the earth began to assume a definite form, and its curiously punctured roots ramifying in all directions. Beneath the shades of these huge trees grew undergrowth, rivalling in extent and density that found in Tropical South American forests at the present time. Ferns of great height and of endless variety abounded in every direction.

Then think of the mighty change that passed over our land as these forests gradually, slowly but surely, sunk lower and lower, became portions of the sea-bottom and were surrounded by heaps of sand, until changes were rapidly effected. The trees decayed, and, in process of time, formed beds of coal—beds revealing, in their method of occurrence, in their mineral constitution, and in their fossil contents, the mighty changes produced by Time.

Centuries passed, and again a change came over our little England. The land was once more released from its watery prison. And over it roamed animals resembling in many respects our crocodiles, but more dreadful in appearance, constructed on a larger scale, and possessing an apparently insatiable appetite. Then lived the original of the dragon, the half bird and half reptile, whose petrified remains still fill us with wonder and astonishment.

Such are the scenes that fossils enable us to conjure up. Such the state of the world at two epochs,—the carboniferous and the new red sandstone.

YORKSHIRE.

Part I.

"The vale of Yorkshire is the richest and most extensive valley in Britain, if not in all Europe," contends Drake. And it is affirmed by another writer of even greater antiquity, "Nay, for there is no place out of London so polite and elegant to live in as the city of York."

With due reservation for local prejudices, it may be justly conceded to Yorkshiremen that no county in England possesses in greater profusion such rich and perfect examples of every variety of scenery. We find alike rich old sward and pasture-land, fertile corn-fields, well-timbered forests, plenty of thick black fir plantings, with shelter for all sorts of game, clear hill becks abounding with trout; rivers, either broad, fair, and navigable for the greater part of their course—as Ouse, Derwent, and others—or chiefly rocky and picturesque, escaping from the moutains, and running along the valleys which, in olden times, the sea channelled out for them—as Swale,* Esk, Rye, Ribble, Lune, and the northern half of the Tees. The grouse, plover, and lapwing cry and wail on endless ranges of moor, which, purple and yellow in their season, are yet so black and dreary for the greater part of the year as to leave their mark in the very names of the surrounding district; thus we have Helmsley Black-a-moor, Whitby Black-a-moor, Kirby Moorside, &c. While of other names bestowed, either in apparent reference to some horrible crime or tragedy now forgotten, or specially to indicate the rugged and gloomy character of the surrounding scenery, there are numerous examples—such as Bloody Beck, Black Hambleton, Hellgill, Black Brow, Wild Boar Fell, Black Holes, Hell-Pot, Cauldron Snout, Hagg Holes. Again, Baldersdale, Balder Beck, Woden Beck, and Woden's-croft are names clearly derived from the Scandinavian gods of our ancestors, and are relics, or fossil words, which in themselves alone convey a history.

There are ranges of round, green-covered chalk hills called wolds, as well as innumerable crags, nabs, cliffs, scars, heads, peaks, toppings, edges, fells; these being all local term signifying abrupt heights. Thus, Brimham Crags, Eston Nab, Whitestone Cliff, Goredale

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* Many of these rivers are spoiled, so far as angling is concerned, by the reprehensible practices of the servants of the lead-mining companies. The lead is separated from the crusted ore by washing; the water is drawn from the nearest beck or pond, and the crushed stone is carried down by the beck to the nearest river, looking about as thick as a glacier stream. This poisonous wash is discharged at a certain hour; the waters of the river are immediately changed from clearness like crystal to a murky leaden hue, and shortly afterwards the fish are drugged and stupified, and half of them lie dead and floating on their backs.

Scar, Burton Head, Rosebury Topping, Blackstone Edge, Wasset Fell. Of lakes, there are Gormore Lake, Simmer Water,* and Malham Tarn, or water.† Of caves, caverns, or, as they are variously called, pots, coves, holes, there are Ingleborough, Yordas, and Weathercote Caves, Hurtle Pot, Gingle Pot, and Malham Cove. These caverns are chiefly to be found in the north-western or limestone district, and contain either water or visible traces of the agency of that element.‡ Many of them are richly clothed with stalactites of brilliant sparry deposit standing in shaft-like pillars from roof to base. Of water-falls, or forces, as they are called, there are many of considerable size and power. Hardraw Force, High Force, and the fall in Weathercote Cave, are among the most picturesque. The mountains are too numerous to notice in detail. Mickle Fell, and Shunnor Fell, are the highest in the North Riding. Ingleborough§ and Whernside‖ are pre-eminent in the western division, while Burton Head (one of the kind containing sandy and argillaceous rocks, and resting upon the upper lias shale) and Black Hambleton (one of the tabular oolitic hills) are the highest in East Yorkshire.

The castles, or the remains of those magnificent strongholds which seem to have once guarded every assailable place or pass, are too well known by name to be described here. Those of Bolton, Scarborough, Pickering, Pontefract, Sherriff, Hutton, Wresill, and Knaresbro', are of historical note. Of Castle Howard, which does not resemble, in origin or appearance, any of the above, Gent thus speaks—

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* *Simmer*. This word is supposed to be a combination of two others, *see* and *meer* both signifying lake.

† *Tarn*. From the Danish word *taaren*, or trickling of tears, by which we understand a deposit of waters gathered together by the many tricklings from the surrounding perpendicular rocky heights, but, unlike a lake, having no distinct feeder or outlet.

‡ The waters of Hurtle Pot are noted for abounding in black trout.

§ *Ingleburg*. Signifies fire or beacon mountain.

‖ *Whern*, anciently *Quernside; Quern* being the German name for a hand-mill, such as might have been cut from the millstone grit of the surrounding district.

> Whose archéd walks adorn the twilight grove,
> Where Strephon mourned and Sylvia's tears did move.

In the number, extent, and beauty of the abbeys which remain to her, Yorkshire can fairly compete with any county in Great Britain. Rivaulx, Fountains, Byland, Kirkham, Egglestone, (A.D. 1189,) Kirkstall (often called Cristal Abbey, because of the limpidity of its pleasant streams), Coverham, Bolton Abbey, Drax Abbey, St. Hilda's Whitby, Jervaux Abbey, and Wykeham Abbey (once a priory of nuns), furnish a noble treat to the antiquary.

Probably as regards natural beauties, the crowning distinction of the county is to be found in the size, number, and remarkably diverse character of its dales, some unfolding scenery of a very picturesque and lovely kind, while that of others is of a wild, rugged, and gloomy character. In this distinction Westmoreland only can fairly be esteemed as a rival. The Yorkshire dales are simply innumerable. It would be tedious to name them, for they can be counted by the half-hundred. Wensleydale and Bilsdale are two of the largest, being twelve or thirteen miles in length.

PART II.

Whatever may happen in time to come, now, at any rate, Yorkshiremen have a pride in the vastness of their county as compared with others, so that it is their boast that it exceeds in size by six times the smallest county in England—we say, whatever may happen, for there are, undoubtedly signs that the sea is stealthily but surely winning back its own; or what our neighbours would call revindicating its frontiers. Hornsea was once ten miles from the sea, which it now overlooks. In 1828, part of Outthorne remained, and the church-yard, containing a curious old tombstone, was still in existence. Twelve years afterwards, all had disappeared beneath the waves. On old Yorkshire maps we read, "Here stood Auburn, washed away by the sea," "Hydc lost in the sea," "Hartburn washed away by the sea;" and, in still older documents, other names, now passed away beyond the memory of any living man, are recorded as then indicating well-known villages or towns. Whether it will ever be again, as geologists tell us it once was, the Vale of York, ocean covered, Creyke an island, and Black Hambleton a sea cliff, as Whitby is at this moment, none can say; but nowhere are relics of the past to be found in greater richness or profusion than in Yorkshire. At a period which in geological reckoning is of a very recent kind, the elephant, rhinoceros, hippopotamus, hyæna, &c., must have prowled about in the valleys and on the mountains, since their bones, teeth, &c., are continually found deeply imbedded in certain strata. In the celebrated Kirkdale Cave, (which now stands about thirty feet above the level of the little river Bran, but was probably once situated on the margin of an inland lake,) a discovery was made some years ago of a perfect treasure of these relics. Bones not only of the above-named animals were found, but also of the tiger, ox, stag, &c. Very perfect remains of the plesiosaurus and other aquatic reptiles disinterred in the neighbourhood of Whitby refer to a vastly earlier stage of the world's history; and geological monuments are not wanting which point to periods greatly exceeding even this in antiquity; periods in which no trace of organic life has ever yet been found.

The greenish slate rocks of Ingleton, Coniston Fells, and Hougill Fells, are monuments of the oldest period in which trace of life has been discovered in Yorkshire. Then came the coloured marls which accompany the old red sandstone series, and these are found in the neighbourhood of Kirkby Lonsdale, and so on with the evidence of each successive epoch, until at length we arrive at the last great elevation of land from out of the glacial sea, when the vales of York, Pickering, and Holderness were left above the ocean level, and as they exist at present.

Geologically, the county of Yorkshire might be described as an apple divided into two, and then transversely severed across into four parts, for in this fashion are the vales and lowlands arranged, taking them as the natural divisions. The Vale of York, running nearly due north and south, but inclining a little to the north-west, and the Vale of Pickering lying at right angles with that of York, and extending (along with the Vale of Esk) from York to the east coast, through Malton, and towards Whitby, while Ribblesdale runs westerly by Knaresbro', Gisburn, and above Settle, Skipton, and Clitheroe. The land, as a whole, rises in masses to the west, or limestone district, and is also higher in the north than in the south, but the hills themselves are distinguished by Professor Phillips as lying in groups and occupying the four regions north-east, north-west, south-east, and south-west.

Legally, however, Yorkshire is divided into three Ridings (trithings, or thirdings, as is the old reading)—north, east, and west; each having well-marked characteristics of its own, not only in geology and scenery, but in the dialect, character, and pursuits of the inhabitants. Briton, Roman, Saxon, Dane, and Norman, have all contributed to make the Englishman, and consequently the Yorkshireman.

Nevertheless it is only with great reservation that anything definite can be said as to the particular race which predominates in each district. In some extremely sequestered parts, men are found who proclaim in feature and appearance their descent from the old British stock. But the Saxon type certainly preponderates in the inland dales, the Celtic in the West Riding, and the Danish along the coast. The Saxons are fair, tall, and stalwart; and in disposition just, self-controlled, slow of belief, stolid in manner, and with the power of quickly adapting inclination to circumstances. The second (or Celtic) are shorter, swarthy, and much more excitable, with a fondness for music and the drama. The last (the Danes) are bold, dark men, with somewhat massive limbs for their height; they embrace and cleave to a maritime life, as becomes their race. These men are our best fishermen; they become our boldest sailors, and, on the coast line, from Dunbar, in Scotland, to Holderness, in Yorkshire, are the fisheries which form the nursery ground for our future tars. They generally dwell entirely apart from the inland inhabitants; as, for instance, we see in Berwickshire, Coldingham village, and Coldingham shore (the fisherman's village), Cockburnspath village, and Cockburnspath cove, ditto. They have their own separate customs, festivals and merry-makings. Many among them are teetotallers; those, who are not, generally get very drunk once a week, *i.e.*, on the Saturday night. Their women sell the fish, rule the house, and bear the purse. The men commonly defer greatly to the women, and in cases of fighting and brawls (not unfrequent) the women never hesitate to part the combatants and bear away each her respective husband to his own home.

The pursuits and callings of the people of the three Ridings are quite unlike in kind. The West Riding is industrial, and abounds in spinners, weavers, mechanics, and artizans. The East Riding is essentially a pastoral country. Shepherds, graziers, and farmers live therein, and cultivate the alluvial mud and rich fat soil. The North is pastoral, agricultural, and partly mining in character. The lead mines in Arkendale, Swaledale, &c., and the ironstone in Rosedale and Cleveland, are annually increasing the proportion of the population who earn their subsistence in the mines and quarries. In all the Ridings the sentiment is strong in the heart of the natives, that not only their county is the best and finest in England, but that their Riding surpasses, in all things, the other two.

Clear proof of early Teutonic habitation is afforded by the numerous towns which bear the Anglo-Saxon termi*nation of ton, as* Northallerton, &c.; *ham* "home" (heim in *South Germany), as* Malham. &c. ; and *ley*, as Helmsley,

&c. *By*, which is a Danish termination, is, in accordance with our previous remarks, chiefly found along the coast, as Whitby, Selby, Hunmanby, &c.

Evidence of the language of the ancient and powerful Brigantian race is decisively stamped on the names of the Yorkshire rivers; some of these derivations we subjoin as being suggestive and full of poetry :—

Rivers.	Signification.
Aire, ...	Rapid stream.
Calder, ...	Woody water.
Douglas, ...	Blue water.
Eden, ...	Gliding stream.
Humber, ...	Confluence of two waters.
Ribble, ...	Tumultuous.
Dun, ...	Dusky.
Derwent, . . .	Fair water.
Dove, ...	Black.
Greta, ...	Swift.
Nid, ...	That whirls.
Wharfe, ...	Rough.

The same remark is applicable to the names of mountains; Penyghent, Penhill, and Pendle-hill being all traceable to the same root.

Tumuli (or old burial heaps) are generally termed "hows" throughout Yorkshire. Heather is spoken of as "ling." Whin is "gorse" or "furze." "Thorpe" is a small farm or hamlet; and in the east, "wyke" is a little bay; "grip" a small drain; and "griff," a narrow, rugged glen. A Yorkshire "tyke" is a well-known expression, signifying now a sharp cunning fellow, but, in its original acceptation, an old horse. "Teeastril" is a villain or rascal; a broad striped pattern is "breead ratched";* to scold is to "flyte." A "gowpin" is a double-handful; a "reeking creak"† is the crook suspended from the beam within the old wide chimney by which to suspend pots or pans. "He toomed and toomed, but never typed," would be that a man swayed, (or nearly overbalanced) but did not fall over. ‘Ask is dry or hard, "clarty" is sticky. "It is a soft day," means a wet day. "Draff" is used for grains indifferently the sediment of rivers or floods is called "warp;" "dree" means long, and "dowly," dismal; to "fettle off" a horse, garden, or gate, is to trim them up; "dench" signifies over-fastidious. "Thou art a feckless sluthergullion" (*i.e.*, fingerless slovenly lounger, a maligner), we heard an old woman exclaim: "And thou art the illest contrived auld wife i' the toon," was the retort. Sometimes the diminutives have the same character as the Scotch; thus "plummock" is a little plum. One day two young lads were busy robbing an orchard; one was aloft in a damson plum-tree, pulling the fruit at random and throwing them below to his comrade; the other at the foot was engaged in hot haste, stuffing them into his pockets, and from time to time hurriedly bolting one down his throat. Silence and expedition being imperatively incumbent in the situation, the first had not much time to select which to gather, nor the other which to put into his mouth. Suddenly the lad below inquired fearfully of the one above, "Tom, has plummocks footlikins (*i.e.*, little feet)?" "Nooa," roared Tom. "Then," said Bill, with a manly despair, "then I ha' swallowed a straddly-beck." Now, a straddly-beck is a frog, from straddle to *stride* over, and *beck*, a ditch or rivulet.—*Cornhill Magazine.*

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* *i. e.* braid stretched.

† "Reek" is the Yorkshire term for "smoke."

SAXON WORDS.

Old Saxon words, old Saxon words, your spells are round us thrown,
Ye haunt our daily paths and dreams with a music all your own;
Each one, in its own power a host, to fond remembrance brings
The earliest, brightest aspect back to life's familiar things.

Yours are the *hills*, the *fields*, the *woods*, the *orchards*, and the *streams*,
The *meadows* and the *bowers* that bask in the sun's rejoicing beams;
'Mid them our childhood's years were kept, our childhood's thoughts were reared,
And by your household tones its joys were evermore endear'd.

We have wander'd where the myrtle bloom'd in its own unclouded realms,
But our hearts returned with changeless love to the brave old Saxon *elms*,
Where the laurel o'er its native streams of a deathless glory spoke,
But we passed with pride to the later fame of the sturdy Saxon *oak*.

We have marvelled at those mighty piles on the old Egyptain plains,
And our souls have thrill'd to the loveliness of the lonely Grecian fanes;
We have linger'd o'er the wreck of Rome, with its classic memories crown'd,
But these touch us not as the mouldering walls with the Saxon *ivy* bound.

Old Saxon words, old Saxon words, they bear us back with pride,
To the days when Alfred ruled the land by the laws of Him that died;
When in one spirit, truly good and truly great, was shewn
What earth has owed, and still must owe, to such as Him alone.

There are tongues of other lands that flow with a softer, smoother grace,
But the old rough Saxon words will keep in our hearts their own true place;

Our household hearths, our household graves, our
household smiles and tears,
Are guarded, hallow'd, shrined by them—the kind fast
friends of years.

Old Saxon words, old Saxon words, your spells are
round us thrown,
Ye haunt our daily paths and dreams with a music all
your own;
Each one in its own power a host, to fond remembrance
brings
The earliest, brightest aspect back of life's familiar
things.—*Mrs. C. Tinsley.*

THE TIDES OF RIVERS.

There is a circumstance connected with the subject of the tides which may have suggested a difficulty in the minds of some of our readers. When we speak of a tide-wave advancing at the rate of fifty or a hundred miles in an hour, we are apt at once to think of a current of water running at that rate, whereas, everybody knows that it is a very strong tide that runs at the rate of four miles an hour. A little attention will shew that the advance of the ridge of the tide-wave is a very different thing from the motion of the current in the water. If a ship were becalmed at the entrance of the English Channel, she would be lifted by the high-water tide, we will suppose, at three o'clock in the afternoon. A fleet riding at anchor in the Downs, would be lifted by the very same tide-wave at twelve o'clock that night, the wave having passed all the way up the Channel, at the rate of about fifty miles an hour. But the motion of the water which would carry the first ship *along*, or be observed as the rate of the current *past* the ship at anchor, would probably not be above two miles an hour; and might not be even in the same direction with that of the tide-wave.

Any person may easily convince himself that the motion of waves is not necessarily accompanied with a current of the water in the same direction, by throwing any light substance into the sea a little beyond the breakers, or into a piece of standing water, the surface of which is ruffled. He will see that such a floating body rises and falls with the motion of the waves, but does not perceptibly move towards the shore.

A field of corn gives another very good instance of *waves*, without any advancing *motion* of the parts which form them. We may see the waves chase one another over the bending tops of the corn; but every ear that is bent down comes back to its first position.

In the tides, however, there is usually *some* current occasioned by the advance of the tide-wave: and this tide is stronger in places where the sea is shallower, or in funnel-shaped channels, such as the mouth of the Severn, or of other large rivers. It must be carefully observed, however, that the change in the *direction* of this current is quite a different thing from the change in the rise and fall of the water.

The nature of the tide in large rivers will be easily understood, after what has been said respecting the tide in narrow seas. Whenever the top of a tide-wave reaches the mouth of a river, it raises the water there, and sends an undulation up the river which advances with greater or less rapidity, (according to circumstances, checking the current, but not always driving it back), and causing high-water in succession, as it reaches the different parts of the river. The tide-wave advances up the Thames at about twenty miles an hour. We have no rivers in England which are long enough to shew the whole effect of the tide-wave in its progress; but in the great rivers of America, and in other parts of the world, it may be distinctly traced. Thus, in the river Delaware, upon which the town of Philadelphia is built, it is high water at Philadelphia at the same time as at the mouth of the river, one hundred and forty miles distant: and about half-way down there is low water at the same instant. Again, when it is high water at the *middle* point, it is low water at the two extremities. The surface of that part of the river which lies between the capes, at the mouth of the Delaware, and the city of Philadelphia, forms a long wave, the distance from ridge to ridge being one hundred and forty miles: when it is high water at Philadelphia and at the mouth, the wave has the position represented in fig. 1, in which P represents Philadelphia and C the capes: and when it is low water at the same points, the surface has assumed the position represented in fig. 2: the water having sunk at the two extremities, and risen in the middle.

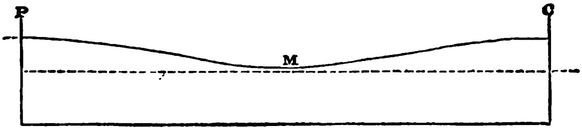


Fig. 1.

In rivers of very great length there may be several of these tide-waves going on at once, causing high water at every ridge, and low water at every hollow; and producing the different variations of the tide at the corresponding points of each wave, in the manner represented in fig. 3.

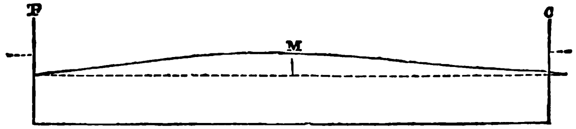


Fig. 2.

It is therefore a great mistake to suppose that when it is high water, for instance, at London Bridge, the water is at the same level all the way down the river. The water will continue to rise at London Bridge some time after it has begun to sink at Gravesend, and again will be sinking at London Bridge for an hour after the water has begun to rise at Gravesend.

It will be seen, also, that although the water is much deeper at any *place*, at high water than at low water, yet, in a whole river of great extent there may not be much more water at one time than at another; and that the currents caused by the tides will, upon the whole, act as much one way as another.

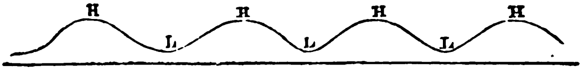
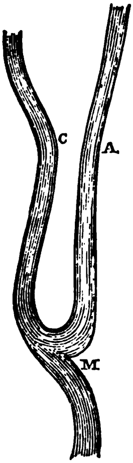


Fig. 3.

On the coast of Suffolk, near where an opening has been made into the sea, to form a canal which shall be navigable for ships to Norwich, a circumstance is said to occur which shews very clearly the motion of the tide-wave up the channel of a river. Upon a great part of that coast the sea is constantly throwing up a shingly beach, which stops the straight course of the rivers into the sea, and causes them to run along within a few yards of the sea before they can find an outlet. Such a river runs near the coast at C, where its mouth originally was: but it is there turned to the southward by the high beach, and really enters the sea at M, some miles lower down. Now it is high water *in the sea* at A when the tide-wave, coming from the north, arrives there; it is high water at M somewhat later; but it is not high water at C, *in the river*, until the tide-wave from M has been propagated along the narrow and winding bed of the river from M to C. It so happens, that nearly six hours are taken up in the progress of the tide-wave from A round M to C; so that by the time it is ***high water*** at C in the *river*, it is *low water* in the *sea* at A, only a few yards distant; and, again, when it is low water at C, it is high water at A.



The height of the tides at different places depends upon the direction and form of the coast, and other causes, which vary with almost every different situation. The highest tides upon the coast of England occur in the Severn, where the tide-wave comes in in one large ridge, accompanied with a roaring noise, and with such violence as often to prove destructive to the small craft. It rises there to the height of forty feet.

The reason of the height of this tide is easily seen. The mouth of the Bristol Channel is very wide, and opens to the south-west, so as to receive the tide-wave from the Atlantic Ocean; but the Channel becomes narrower by degrees, and near Chepstow is very much contracted; the water is, therefore, heaped up at the other end of the Channel, much above the level to which it would otherwise rise.—*S. M.*

DISTRIBUTION OF PLANTS AND ANIMALS.

How many different kinds of plants one sees in the fields! What endless variety exists! Each nook conceals from our view some stray plant, found only after close examination. And if so many are found in one field, what immense numbers there must be in Great Britain! And, what must be the number of varieties of trees and plants found throughout the world?

And yet all these apparently endless varieties are arranged with great taste and skill by the hand of Nature; and each plant and each tree can be assigned to its own class by the botanist. Every country possesses its own vegetation; every country produces that for which its climate is best fitted Walk through a botanical garden, and at once you will see the marked contrasts presented by the vegetation of different countries. Here are tall, towering palms from Africa, there are the sweet-smelling balsams ot Arabia, here are the long narrow-leaved plants of Australia, there is the woody interlaced work of the climbing plants of South America, while in another part are the shady trees of our own dear England.

What causes these differences? Climate. Why do not all countries possess the same kind of vegetation? Because they do not all possess the same climate. No two places on the earth's surface possess exactly the same climate, and the further we proceed from the equator, or the higher we ascend mountains, the more do we find the face of nature to change. It is as though the earth assumed various dresses to suit her various climates.

Now, let us take a few of the terms used with regard to plants and animals. Plants and animals can be viewed as distributed either in horizontal or vertical space; the former refers to their distribution, at the sea-level, from the equator to the poles, the latter refers to their distribution up the sides of a mountain. The entire vegetation of a country is called its *Flora*. The entire group of animals peculiar to a country, is called its *Fauna*. The general aspect of a country's vegetation is called its *facies*, thus we may say that the facies of North American vegetation resembles that of Northern Europe. Plants which belong to similar classes, but have developed differently under the influences of climate, are said to be *representative*, while plants peculiar to certain countries are said to be *characteristic*. The same terms are applied to animals.

Man has effected many changes in the distribution of vegetable and animal life. He has removed and transplanted, to such an extent, that in many cases the old floras have ceased to exist. Australia has, for instance, a characteristic flora. Its vegetation resembles that of no other part of the world. When men first visited it, they said it was a land of anomalies, every thing grew the wrong way; the cherry grew with the stone outside; many trees grew with their roots in the air, ferns grew to the size of trees. But these stories proved untrue.

Those who brought them were deceived. The species of plants that they saw in Australia were totally different to the species they saw in England. They belonged to different classes. The hot, dry, parched soil of Australia could only produce the tall, thin shrivelled-up plants they had seen. Since then, Australia has been colonized; methods of irrigation have been introduced, and plants, similar to our own, now flourish.

The South American forests are rich in flowers of gorgeous colours, and thickly interwoven trees; the climbing plants form such a complete net-work, that in many parts the forests are impassable. In the tropical regions of Asia, vegetation is equally rich, but developes itself differently under different influences. There the banyan-tree flourishes, the camphor-tree, the cotton-tree, the rice plant, and all kinds of palms and tree ferns. The Tropical regions of Africa, on the other hand, are remarkable for the scantiness of their vegetation.

From America and Western Asia we, in Europe, have received the greater portion of our plants and trees, and yearly more plants are transplanted and acclimatized.

The colder the climate gets, the lowlier the species of vegetation that exists, until, on the shores of the Atlantic and on the tops of the highest mountains, the only life existing consists of lichens and mosses.

Many animals depend upon vegetation for their existence. Change the flora of a country, then, and you will at once change its fauna. Since the colonization of Australia the old animals have begun to die out. A few more years will see the extinction of the kangaroo, the dingo, and some other species of animals now found there.

Animals are also representative and characteristic. The three just mentioned are characteristic of Australia; they are found only in that continent and the islands immediately to the north of it. The lion of Asia differs from the lion of Africa, while the puma (a much smaller animal), represents the class in America. Tigers again differ in the two continents, and are represented in South America by the jaguar. The gorilla of Western Africa differs from the ourang-outang of the East Indian Archipelago. Two species of camel exist. Western Asia is the "true home of the horse and the ass."

Animals are more migratory in their habits than plants, since they possess methods of locomotion, but still they are restricted to certain districts, only leaving them when the climate becomes too severe. Swallows and cuckoos are examples of this class. Europe is the home of singing birds; South America of talking birds; and Tropical Asia of birds of brilliant plumage.

Insects abound more even than birds or beasts. No less than 300,000 kinds are known. Humboldt, the great German traveller, when travelling in South America, could always tell the time by the kinds of insects flying about. Tropical regions are peopled with thousands of insects. "There they fill the air with their hum and make the landscape glow and sparkle with light at night. As the navigator ploughs through some seas, his keel leaves a broad bright wake to mark its passage, owing to the immense multitudes of phosphorescent insects it has disturbed in its silent path; and, when the sun sets upon Central America, where insect life most abounds on land, the forests and plains resound with their hum, which is said to have been heard by mariners several miles out at sea. There, too, the curtain of night is spangled with the most glittering jewels of the insect world. Fireflies, bearing their green, red, and white lanterns, and shewing them, now as fixed, now as sinking lights, cause the darkness to glow and sparkle again with countless flashes. In Brazil the insects present the most brilliant colours, surpassing even the plumage of the birds and flowers—gorgeous as these are."—*Maury.*

The inhabitants of the sea, also, have their bounds, which they cannot pass. The "right" whale, as it is termed, of the northern seas differs from the whale of the southern seas; neither of them cross the Equator.

Each thousand feet of descent has its special plants and its special inhabitants.

The ocean has representatives of all the great classes of animals, from the highest to the lowest represented by the sponges.

THE LION.

THE most interesting object of a menagerie is probably its lion: and there are few persons who are not familiar with the general appearance of this most noble animal. To behold, in perfect security, that creature which is the terror of all travellers in the regions where he abounds: which is said to be able to bear off a buffalo on his back, and crush the skull of a horse by a single stroke of his paw; this is certainly gratifying to a reasonable curiosity. The appearance of dignified self-possession which the lion displays when at rest; his general indifference to slight provocations: his haughty growl when he is roused by the importunities of his keepers or the excitement of the multitude: his impatient roar when he is expecting his daily meal, and his frightful avidity, when he is at length enabled to seize upon his allotted portion,—these are traits of his character in confinement which are familiar to almost every one.

To comprehend the habits of the lion, we must follow with attention the narratives of those travellers who have seen him in his native haunts. From the Cape of Good Hope, for instance, an adventurous naturalist sets forth to explore the immense plains of the interior of Southern Africa. His journey is performed partly on foot, and partly in a waggon drawn by eight or ten oxen. His escort consists of a few sturdy Hottentots, accustomed to the country into which he desires to penetrate—excellent marksmen—and expert in following up the track of every wild or ferocious beast. Further and further he rolls on from the abodes of civilization, and soon finds himself surrounded by tribes of Bushmen or Caffres, who live in a rude but contented manner, depending for subsistence upon their flocks and upon the chase, and knowing very few of those agricultural arts by which their arid plains might be partially redeemed from sterility. At length he reaches those parts where ferocious animals abound; and where the lion particularly is an object of dread. Having passed the borders of European colonization, his fears are first excited by viewing the footmarks of the lion. His Hottentot guides have their tales of terror ready for the traveller, who beholds for the first time the impress of those tremendous feet upon the sands of the plain which he is to cross; and they are ready to shew their skill in tracking, if necessary, the prowling savage to his lair. A lowering evening comes on; thunder clouds collect in every quarter; and the night becomes extremely dark. The most vivid flashes of lightning are intermingled with the heaviest torrents of rain. The cattle are restless; and the Hottentots are prevented making their evening fire for the cookery of their supper, and for defence against the beasts of prey. On such nights as these the lion is particularly active. The fury of the elements appears to rouse him from his ordinary torpidity. He advances upon his prey with much less than his usual caution; and he is not at once driven off by the barking of dogs and the sound of muskets. The oxen of the caravan, who appear to scent the distant approach of their terrible enemy, struggle to break loose from their waggons to escape their danger by instant flight—an escape which would prove their destruction. It is only by keeping with man that they are safe. The repeated discharge of fire-arms has the remarkable effect, not only of keeping off the lion, but of abating the restlessness of the cattle. They appear to feel that their enemy will retreat when he hears this demonstration of the powers of the only creature that is enabled by superior reason to cope with him. Nights of such harassing watchfulness are not unfrequently experienced by the African traveller.

To the traveller in Africa the lion is formidable not at night only; he lies in his path, and is with difficulty disturbed to allow a passage for his waggons and cattle, even when the sun is shining with its utmost brilliancy or he is roused from some bushy place on the road side, by the indefatigable dogs, which always accompany a caravan. Mr. Burchill has described, with great spirit, an encounter of this nature:—"The day was exceedingly pleasant, and not a cloud was to be seen. For a mile or two we travelled along the banks of the river, which in this part abounded in tall mat rushes. The dogs seemed to enjoy prowling about and examining every bushy place, and at last met with some object among the rushes which caused them to set up a most vehement and determined barking. We explored the spot with caution, as we suspected, from the peculiar tone of their bark, that it was, what it proved to be, lions. Having encouraged the dogs to drive them out, (a task which they performed with great willingness) we had a full view of an enormous black-maned lion, and a lioness. The latter was seen only for a minute, as she made her escape up the river, under concealment of the bushes; but the lion came steadily forward and stood still to look at us. At this moment we felt our situation not free from danger, as the animal seemed preparing to spring upon us, and we were standing on the bank at a distance of only a few yards from him, most of us being on foot and unarmed, without any visible possibility of escaping. I had given up my horse to the hunters, and was on foot myself, but there was no time for fear, and it was useless to attempt avoiding him. I stood well upon my guard, holding my pistols in my hand, and with my finger upon the trigger; and those, who had muskets, kept themselves prepared in like manner. But at this instant the dogs flew boldly in between us and the lion, and surrounding him, kept him at bay by their violent and resolute barking. The courage of these faithful animals was most admirable; they advanced up to the side of the huge beast, and stood making the greatest clamour in his face, without the least appearance of fear. The lion, conscious of his strength, remained unmoved at their noisy attempts, and kept his head turned towards us. At one moment, the dogs perceiving his eyes thus engaged, had advanced close to his feet, and seemed as if they would actually seize hold of him, but they paid dearly for their impudence, for, without discomposing the majestic and steady attitude in which he stood fixed, he merely moved his paw, and at the next instant I beheld two lying dead. In doing this, he made so little exertion that it was scarcely perceptible by what means they had been killed. Of the time which we had gained by the interference of the dogs not a moment was lost; we fired upon him, one of the balls went through his side just between the short ribs, and the blood immediately began to flow, but the animal still remained standing in the same position. We had now no doubt that he would spring upon us; every gun was instantly re-loaded; but happily we were mistaken, and were not sorry to see him move quietly away: though I had hoped in a few minutes to have been enabled to take hold of his paw without danger.

This was considered, by our party, to be a lion of the largest size, and seemed, as I measured him by comparison with the dogs, to be, though less bulky, as large as an ox. He was certainly as long in body, though lower in stature; and his copious mane gave him a truly formidable appearance. He was of that variety which the Hottentots and Boors distinguish by the name of the black lion, on account of the blacker colour of the mane, and which is said to be always larger and more dangerous than the other, which they call the pale lion. Of the courage of a lion I have no very high opinion, but of his majestic air and movements, as exhibited by this animal, while at liberty in his native plains, I can bear testimony. Notwithstanding the pain of a wound, of which he must soon afterwards have died, he moved slowly away with a stately and measured step."

At the time when men first adopted the lion as the emblem of courage, it would seem that they regarded great size and strength as indicating it; but they were greatly mistaken in the character they have given to this indolent, skulking animal, and have overlooked a much better example of true courage, and of other virtues also, in the bold and faithful dog.—*Library of Entertaining Knowledge.*

CRUELTY TO ANIMALS.

I WOULD not enter on my list of friends
(Though grac'd with polish'd manners and fine sense,
Yet wanting sensibility), the man
Who needlessly sets foot upon a worm.
An inadvertent step may crush the snail,
That crawls at evening in the public path;
But he, that hath humanity,—forewarned,
Will step aside, and let the reptile live.
The creeping vermin, loathsome to the sight,
And charged, perhaps, with venom, that intrudes—
A visitor unwelcome—into scenes
Sacred to neatness and repose,—the alcove,
The chamber, or refectory,—may die:
A necessary act incurs no blame.
Not so, when, held within their proper bounds,
And guiltless of offence, they range the air,
Or take their pastime in the spacious field:
There they are privileged; and he that hunts
Or harms them there, is guilty of a wrong,
Disturbs the economy of nature's realm,
Who, when she form'd, designed them an abode.
The sum is this: If man's convenience, health,
Or safety, interfere, his rights and claims
Are paramount, and must extinguish theirs.
Else they are all—the meanest things that are—
As free to live, and to enjoy that life,
As God was free to form them at the first;

Who, in His sovereign wisdom, made them all.
You, therefore, who love mercy, teach your sons
To love it too. The spring-time of your years
Is soon dishonour'd and defiled; in most
By budding ills, that ask a prudent hand
To check them. But, alas! none sooner shoots,
If unrestrained, into luxuriant growth,
Than cruelty, most brutish of them all.
Mercy to him that shews it, is the rule
And righteous limitation of its act,
By which Heaven moves, in pardoning guilty man;
And he that shews none—being ripe in years,
And conscious of the outrage he commits,—
Shall seek it and not find it, in his turn.—*Cowper.*

MAN.

MAN presents a vivid contrast to all plants and animals. While they are restricted in their range, while they are confined within certain limits, he wanders unrestrained by extreme heat or severe cold. He alone, of all Creation, is adapted to wander from Pole to Pole whenever he pleases. Alone, but not quite alone. One single exception, with regard to the distribution of animals, exists; that exception is the dog. He, man's faithful companion, accompanies him in his wanderings beneath the burning sun of India or amid the snows of Lapland.

The human race is divided into a number of classes. The study of the differences, which decide to which of those classes every member of the race belongs, forms a separate science. It is called Ethnology.

The human race has been divided into five varieties. Each division is distinct from the rest by its own special character, the differences between them being either *structural* or *facial.* Structural differences are those caused by various arrangements of the bones which form the skeleton. Facial differences are those caused by the features of the face: thus the races differ in the nature of the hair, the character of the forehead, the nature of the lips, the prominence or receding of the eyes. Facial differences are manifest to all of us. Compare an Englishman and an African, and you will see how wonderfully they differ.

These five varieties of the human race were the Caucasian, the Mongolian, the African, the American, and the Malay.

1 Caucasian

2. Mongolian.

3 Negro (pure type)

4. Malayan

5. Otto Indian of North America.

I. The Caucasian race is the most advanced and the most civilized of all the nations at present existing. They possess a white skin, varying in shade according to the districts they occupy, black or light-coloured hair generally straight, a high forehead, an oval face, and a small mouth. They occupy all the southern part of

Asia, (except the Malayan Peninsula,) and the whole of Europe. Wherever located, the Caucasians have become the prominent race. They seem to be continually extending their territories.

The term "Caucasian" is rather misleading, because it makes one suppose that the model Caucasian is found among the Caucasian mountains. But this is quite wrong. The inhabitants of that part of the world belong to the Mongolian class. Dr. Latham thus speaks of the circumstances under which the name was given: "The author of the above divisions had a solitary Georgian skull, and that skull was the finest in his collection. Hence it was taken as the type of the skull of the more organized divisions of our species. More than this, it gave its name to the type, and introduced the term, *Caucasian.* Never has a single head done more harm to science than was done by the head of this well-shaped female from Georgia."

II. The Mongolians are easily distinguished. The Chinese belong to this class. They have straight foreheads, long straight hair, broad and flat cheek-bones, and yellow skins. A few Mongolian nations have exceeded the district they originally occupied, which consisted of northern and central Asia; the Turks, the Magyars of Austria, and the Laplanders of northern Europe are examples of this variety.

III. No one can mistake an African. His woolly hair, his prominent cheek-bones, his thick lips, and his black skin mark him as distinct from the fair-complexioned Caucasian or the sallow-faced Mongolian. The northern parts of Africa are peopled by descendants of Caucasian races, so that if we wish to see a true negro, we must ascend one of the large streams that empty themselves into the Gulf of Guinea. There the African race is seen in its purity. The Negro race has been the most unfortunate of the five. From early times its members have been enslaved. The present century saw, however, the release of the slave in all civilized countries, and England's efforts to stop the slave-trade, that wicked traffic in the bodies of men, are now nobly assisted by the greatest nations of the earth.

IV. The American variety chiefly comprise the Indian tribes who people that continent. They possess large statures, receding foreheads, aquiline noses, and copper-coloured skins. The race is rapidly decreasing in numbers, and, ere many years have passed, will become extinct; yet they had attained a high state of civilization in Mexico and Peru, when the Spaniards, under Cortez and Pizarro, conquered those countries.

V. The Malays are so named because this variety chiefly exists in the Malayan peninsula. They have dark-coloured skins, low foreheads, and coarse black hair. The Malays proper are distinguished for their immoral habits and piratical pursuits. Some of the members of this group are the lowest in intellect of all the nations. The Australians belong to this division.

Cuvier, after much study, decided that only three varieties of the human race exist—the Caucasian, the Mongolian, and the African; he held that the Americans and Malays were only portions of the Mongolian class. His views are now held by many learned men. Change of climate and change of habits would rapidly cause the inhabitants of America or the Malay peninsula to differ from the Mongolian.

The great types of humanity continue, and the three great races always exist; but the nations, forming those races, attain to periods of prosperity, and then become extinct, as nations. The great conquering nations of the world have died out; witness the Assyrians, the Persians, and the Romans. The most ancient nation is the Jewish; they continue to increase in number, and to be as "the sand upon the seashore," but they have never regained their ancient prosperity.

THE UNION OF LABOUR AND INTELLECTUAL ATTAINMENTS.

ADDRESS OF THE LATE EARL OF CARLISLE, AT THE SHEFFIELD ATHENÆUM, SEPTEMBER, 1847.

THOSE of you who have had the opportunity of consulting the old legends of classical mythology, are aware that among the fancied deities with which they peopled the world, there was one more especially regarded as the God of labour, and of handicraft, Vulcan by name, who was always represented as being employed in huge smithies and workshops, hammering at heavy anvils, and blowing vast bellows, heating vast furnaces, and begrimed with soot and dirt. Well, for this hard-working, and swarthy-looking divinity, they wished to pick out a wife. And they did not select for him a mere drab—not a person, taken herself from the scullery or kitchen-dresser; but they chose for him Venus, the Goddess of love and beauty. Now, ladies and gentlemen, pick out for me the moral of this tale, for I believe that nothing ever was invented,—certainly nothing by the polished and brilliant imagination of the Grecian intellect,—which has not its own meaning, and its moral.

But what is the special meaning of the marriage of Vulcan with Venus—of the hard-working artificer with the laughter-loving queen—of labour with beauty? What is it but this, that even in a busy hive of industry and toil like this, even here, upon a spot which is in many respects no inapt representative of the fabled workshop of Vulcan, even here, amid the clang of anvils, the noise of furnaces, and the sputtering of forges—even here, amid stunning sounds, and sooty blackness, the mind—the untrammelled mind—may go forth, may pierce the dim atmosphere which is poised all around us, may wing its way to the freer air and purer light which dwells beyond, and may ally itself with all that is most fair, genial, and lovely in creation.

So, gentlemen, I say your labour, your downright, hard, swarthy labour may make itself the companion, the helpmate, and the husband of beauty—of physical beauty, as I have reason to believe, from the inspection which I am able even now to command, and I have no doubt that a more intimate acquaintance with your wives, sisters, and daughters, would enable me to prove that I was not here wrong in my illustration,—but besides this beauty, I say, your labour may ally itself with intellectual beauty—the beauty which is connected with the play of fancy, with the achievements of art, and with the creations of genius; beauty, such as painting fixes upon the glowing canvas, such as the sculptor embodies in the breathing marble such as architecture developes in her stately and harmonious proportions, such as music dresses with the enchantment of sound. Now it is to the perception and cultivation of the beautiful in these departments that I look upon your Schools of Design, and your concerts, and many of the lectures which you hear from able and gifted men, as intended to be subservient; and I strongly advise the members of this Mechanics' Institution to shew a discriminating and generous support of these tasteful and humanizing pursuits. Above all, I advise you to cultivate a love of reading—that which makes you almost independent of other aids and appliances, and puts, with very moderate help, the whole domain of philosophy, history, and poetry, within your individual command.

Why, gentlemen, a man is almost above the world, who possesses two books. I do not mean to put the two books which I am about to mention upon the same level, far from it, nor am I wishing to intimate to you that two books are sufficient for your study and perusal. I am only mentioning them as representatives of what is most excellent, though different in degree. But I say that a man is almost above the world who possesses his Bible and his Shakespeare—his Shakespeare for his leisure—his Bible for all time. I said some time ago, that labour, even the labour of this district, may unite itself with intellectual beauty. But there is a beauty of a still higher order with which I feel even more assured it is still more open to it to unite itself: I mean with moral beauty—the beauty connected with the affections, the conscience, the heart, and the life. It is indeed most true that in the very busiest and darkest of your workshops—in the most wearying and monotonous tasks of your daily drudgery, as also in the very humblest of your own homes—by the very smallest of your fireplaces—one and each of you, in the zealous and cheerful discharge of the daily duty—in respect for the just rights and in consideration for the feelings of others—in the spirit of meekness, and in the thousand charities and kindnesses of social and domestic intercourse,—one and each of you may attain to and exhibit that moral beauty of which I have spoken—that beauty which is beyond all others in degree, because, when it is attained to, it is the perfection of man's nature here below, and is the most faithful reflection of the will and image of his Creator. And thus, ladies and gentlemen, I close my explanation of the marriage of Vulcan and Venus—of Labour with Beauty, and with it I close the remarks which I have risen to offer you this evening.

THE DOUGLAS.

The castle gates were open flung,
The quivering drawbridge rocked and rung,
And echoed loud the flinty street
Beneath the coursers' clattering feet,
As slowly down the deep descent
Fair Scotland's King and nobles went,
While all along the crowded way
Was jubilee and loud huzza.
And ever James was bending low,
To his white jennet's saddle bow,

Doffing his cap to city dame,
Who smiled and blushed for pride and shame.
And well the simperer might be vain,—
He chose the fairest of the train.
Gravely he greets each city sire,
Commends each pageant's quaint attire,
Gives to the dancers thanks aloud,
And smiles and nods upon the crowd,
Who rend the heavens with their acclaims,
"Long live the Commons' King, King James!"
Behind the King thronged peer and knight,
And noble dame and damsel bright,
Whose fiery steeds ill-brooked the stay
Of the steep street and crowded way.
—But in the train you might discern
Dark lowering brow and visage stern;
There nobles mourned their pride restrained,
And the mean burghers' joy disdained;
And chiefs, who, hostage for their clan,
Were each from home a banished man,
There thought upon their own gray tower,
Their waving woods, their feudal power,
And deemed themselves a shameful part
Of pageant which they cursed in heart.

* * * * * * *

Now, clear the Ring! for, hand to hand,
The manly wrestlers take their stand.
Two o'er the rest superior rose,
And proud demanded mightier foes,
Nor called in vain; for Douglas came.
—For life is Hugh of Larbert lame,
Scarce better John of Alloa's fare,
Whom senseless home his comrades bear.
Prize of the wrestling match, the King
To Douglas gave a golden ring,
While coldly glanced his eye of blue,
As frozen drop of wintry dew.
Douglas would speak, but in his breast
His struggling soul his words suppress'd:
Indignant then he turned him where

Their arm the brawny yeomen bare,
To hurl the massive bar in air.
When each his utmost strength had shewn,
The Douglas rent an earth-fast stone
From its deep bed, then heaved it high,
And sent the fragment through the sky,
A rood beyond the farthest mark;—
And still in Stirling's royal park,
The gray-haired sires, who know the past,
To strangers point the Douglas-cast,
And moralize on the decay
Of Scottish strength in modern day.

The vale with loud applauses rang,
The Ladies' Rock sent back the clang;
The King, with look unmoved, bestowed
A purse well filled with pieces broad.
Indignant smiled the Douglas proud,
And threw the gold among the crowd,
Who now, with anxious wonder scan,
And sharper glance, the dark gray man;
Till whispers rose among the throng,
That heart so free, and hand so strong,
Must to the Douglas blood belong:
The old men mark'd, and shook the head,
To see his hair with silver spread,
And winked aside, and told each son
Of feats upon the English done,
Ere Douglas of the stalwart hand
Was exiled from his native land.
The women praised his stately form,
Though wreck'd by many a winter's storm;
The youth with awe and wonder saw
His strength surpassing nature's law.
Thus judged, as is their wont, the crowd,
Till murmurs rose to clamours loud.
But not a glance from that proud ring
Of peers who circled round the King,
With Douglas held communion kind,
Or called the banished man to mind;

No, not from those who, at the chase,
Once held his side the honoured place,
Begirt his board, and, in the field,
Found safety underneath his shield;
For he, whom royal eyes disown,
When was his form to courtiers known!

The Monarch saw the gambols flag,
And bade let loose a gallant stag,
Whose pride, the holiday to crown,
Two favourite grey-hounds should pull down,
That venison free, and Bordeaux wine,
Might serve the archery to dine.
But Lufra,—whom from Douglas' side
Nor bribe nor threat could e'er divide,
The fleetest hound in all the North,—
Brave Lufra saw, and darted forth.
She left the royal hounds mid-way,
And, dashing on the antler'd prey,
Sunk her sharp muzzle in his flank,
And deep the flowing life-blood drank.
The King's stout huntsman saw the sport
By strange intruder broken short.
Came up, and with his leash unbound,
In anger struck the noble hound.
—The Douglas had endured, that morn,
The King's cold look, the nobles' scorn,
And last, and worst to spirit proud,
Had borne the pity of the crowd;
But Lufra had been fondly bred,
To share his board, to watch his bed,
And oft would Ellen, Lufra's neck,
In maiden glee, with garlands deck;
They were such playmates, that with name
Of Lufra, Ellen's image came.
His stifled wrath is brimming high,
In darkened brow and flashing eye;
As waves before the bark divide,
The crowd gave way before his stride;
Needs but a buffet and no more,

The groom lies senseless in his gore.
Such blow no other hand could deal,
Though gauntleted in glove of steel.

Then clamoured loud the royal train,
And brandished swords and staves amain.
But stern the Baron's warning—" Back!
Back on your lives, ye menial pack!
Beware the Douglas."—" Yes! behold,
King James, the Douglas, doomed of old,
And vainly sought for near and far,
A victim to atone the war,
A willing victim now attends,
Nor craves thy grace but for his friends."—
" Thus is my clemency repaid,
Presumptuous Lord!" the Monarch said;
" Of thy mis-proud ambitious clan,
Thou, James of Bothwell, wert the man,
The only man, in whom a foe
My woman mercy would not know:
But shall a Monarch's presence brook
Injurious blow, and haughty look?—
Who ho! the Captain of our Guard!
Give the offender fitting ward.—
Break off the sports!"—for tumult rose,
And yeomen 'gan to bend their bows.—
" Break off the sports!" he said, and frowned,
" And bid our horsemen clear the ground."

Then uproar wild and misarray
Marr'd the fair form of festal day.
The horsemen pricked among the crowd,
Repelled by threats and insult loud;
To earth are borne the old and weak,
The timorous fly, the women shriek;
With flint, with shaft, with staff, with bar,
The hardier urge tumultuous war.
At once round Douglas darkly sweep
The royal spears in circle deep,
And slowly scale the pathway steep;

While on their rear in thunder pour
The rabble with disordered roar.
With grief the noble Douglas saw
The commons rise against the law,
And to the leading soldier said,
"Sir John of Hyndford! 'twas my blade
That knighthood on thy shoulder laid,
For that good deed, permit me then
A word with these misguided men.

"Hear, gentle friends! ere yet, for me,
Ye break the bands of fealty.
My life, my honour, and my cause,
I tender free to Scotland's laws.
Are these so weak as must require
The aid of your misguided ire?
Or, if I suffer causeless wrong,
Is then my selfish rage so strong,
My sense of public weal so low,
That, for mean vengeance on a foe,
Those cords of love I should unbind,
Which knit my country and my kind?
Oh no! Believe, in yonder tower
It will not soothe my captive hour,
To know those spears our foes should dread,
For me in kindred gore are red;
To know in fruitless brawl begun,
For me, that mother wails her son;
For me, that widow's mate expires,
For me, that orphans weep their sires,
That patriots mourn insulted laws,
And curse the Douglas for the cause.
Oh let your patience ward such ill,
And keep your right to love me still!"

The crowd's wild fury sank again
In tears, as tempests melt in rain.
With lifted hands and eyes, they prayed
For blessings on his generous head,
Who for his country felt alone,

And prized her blood beyond his own.
Old men, upon the verge of life,
Blessed him who stayed the civil strife;
And mothers held their babes on high,
The self-devoted chief to spy;
Triumphant over wrong and ire,
To whom the prattlers owed a sire:
Even the rough soldier's heart was moved;
As if behind some bier beloved,
With trailing arms and drooping head,
The Douglas up the hill he led,
And at the castle's battled verge,
With sighs, resigned his honoured charge.

—*Scott's " Lady of the Lake."*

DEVELOPMENT OF THE INTELLECT.

ADDRESS OF THE LATE EARL OF CARLISLE, DELIVERED AT THE MECHANICS' INSTITUTION, LINCOLN, 1851.

I KNOW that the enemies of Mechanics' Institutes, and of popular institutions generally, have been apt to say that they have a tendency to make the mechanics and working men, whom especially they are intended to benefit, puffed up, presumptuous, conceited, and discontented. All I can say is, that if they do so, they fail singularly in their purpose, and fall far short of their aim. It appears to me that there are two principles upon which we must mainly rely for success in any attempts to raise and regenerate mankind. The one is to have a very high opinion of what we can do, the height to which we can soar, the advance in knowledge and in virtue which we may make,—that is, ambition as concerns our capacities. The other is to have a mean opinion of what we at any time know, or at any time have already done,—that is, humility as concerns our attainments. The ambition should be ever stirring us up to the even and steady developement of righteous principles, and, where the opportunity presents itself, to the performance of noble, meritorious, and unselfish actions. The humility should ever keep in view that there is no sphere of life, however humble, no round of duties, however unexciting, which any of you may not enrich and elevate with qualities beside which the successes of statesmen and the triumphs of conquerors are but poor and vulgar. I believe there is no eminence to which man may not reach, but he must reach it by subordinating all unlawful impulses, and by subduing all mean ambitions. There is a general craving in the human mind for greatness and distinction. That greatness and distinction, I am thankful to think, is within the reach of any one to obtain; but the greatness and distinction must not be without you, but within you.

I should be sorry to appear to take this opportunity of preaching what might be called a sermon, but I feel so fervid an interest in the welfare and progress of the great body of my countrymen, that I cannot refrain from enjoining them, even while I would invite them to a full enjoyment of all the rich resources and all the innocent pleasures of this our variegated world, never to lose hold of religion. I do not mean that you should necessarily confine it within those stiff and narrow grooves in which some would imprison its ethereal spirit; but I feel assured that it is the source among mankind of all that is large, and of all that is lovely, and that without it all would be dark and joyless. Under her sacred wing you may securely resign yourselves to all that is improving in knowledge, or instructing in science, or captivating in art, or beautiful in nature. The Architect of the Universe, the Author of Being, such as Christianity represents Him, cannot but approve of every creature, that He has made, developing to the utmost extent the faculties He has given him, and examining, in all its depth and mystery, every work of His hand. Shut up the page of knowledge and the sources of enjoyment from the multitude, because some have occasionally abused the blessed privilege! Why, the very same argument would consign every man and woman to a cloister, because the world and active life are full of traps and pitfalls. No! Pre-eminent and supreme as I am convinced religion is, yet to make her so in the convictions and hearts of men, I feel she must discard all timidity, must front every truth in the full blaze of light, and sympathize with every pursuit and every impulse of our race.

I have thus briefly shadowed forth the reasons why no person ought to frown upon Mechanics' Institutions. I do not wish to attribute to them any exaggerated or imaginary value; I do not hold them forth as singly containing the elements with which we should hope to regenerate modern society; but it is because I believe them calculated happily to chime in with the existing wants and prevailing dispositions of the times, to afford opportunities for improvement and developement in quarters where they would not otherwise be found, to promote innocent recreation and blameless amusements, and generally to assist the progress of mankind, that I thus venture to recommend them to your cordial sympathy and your active assistance.

ON THE BENEFITS CONFERRED BY EDUCATION.

A SPEECH DELIVERED BY THE LATE EARL OF CARLISLE, AT THE DISTRIBUTION OF PRIZES AT HUDDERSFIELD COLLEGE, DECEMBER, 1863.

WELL, then, my young friends, if you will allow me to turn myself to you,—when the motives for diligent application are so varied and important, when the returns to it are so sure and so promising,—for though we hear very often of bad bargains and ruinous speculations, yet I feel sure, however long your life may be, you will hardly, in the course of it, ever meet with a man who will tell you that he regrets the time which he has spent in the acquisition of knowledge, or repents of having become a scholar,—resolve now, if you never did so before, not to lose those precious hours, the weight of which may be prized in gold, while they have the speed and lightness of feathers; and most of all I wish you to prize beyond all other acquisitions—beyond the acquisition of learning, however solid, or the mastery of accomplishments, however brilliant; prize before them all, the formation of individual character, the building up of moral habits, the whole pervading discipline of duty. Join docility and teachableness in your studies to that independence and resolution of will, which will enable you to apply and to appropriate to yourselves the teachings of others' wisdom, and the lessons of your own experience; so that when the time shall come for your leaving the friendly shelter of this institution, and for launching out your small barks into the wide and stormy sea of life, you may not only carry with you those honourable certificates of approval of your past exertions and conduct, which I have had the satisfaction of delivering to two of your number this day, but you may go forth into the busy arena of the world, and there, whatever may be your special calling,—in literature and art, in science or in business, amidst public avocations or among family connections,—you may at last, one and all of you, be fitted and prepared to play the part of useful Christian citizens.

I would now only gently remind even those who have so honourably come forward in support of this institution, that while they desire to promote the cause of a creditable and liberal education amongst those members of society for whom it is calculated, they must not forget, that in these times it is most indispensable to the welfare and even to the salvation of the country at large, that the benefits of education should not be confined to any particular class of persons; but that they should be extended to every species of occupation, and to every department of society. Given already to the nobles, to the merchants, to the master manufacturers, they ought not to be withheld from the mechanic, the labourer, and the cottager. You have made ample and splendid provision in order to meet the exigencies of those that are, comparatively speaking, in easier circumstances, and in so doing you have done most wisely, and most well. May those classes enjoy and appropriate the advantages thus held out to them; may we hear of your sons giving themselves up with ardour to all the studies of this place; may they delight in the sublime lay of Homer, and the faultless lines of Virgil; may they obtain a proficiency in every polite and graceful accomplishment, or wing their adventurous flight through the highest realms of science! But while they do all this, be it our care also to provide that, if you will, a plainer, but still a sound and substantial nourishment shall be afforded to the bulk of the nation, to those who make the pith and marrow of our people. See that it is put within their reach; see that it offers itself to their notice; see that it wooes their acceptance; even let it be pressed upon them, though they should at first sight seem unwilling to take advantage of it. While you support Academies and Colleges, give your assistance and your countenance also to working mens' classes, and to Mechanics' Institutes. While you amply uphold the credit of Huddersfield College, promote also the prosperity of the day-school and the Sunday-school. Let education be provided for the heirs of poverty and the children of toil, as a genial relaxation from the weary hours of labour; let it be provided for them as a solid and sustaining nurture for the intellectual, the moral, and the spiritual cravings of their nature. And let me give this parting exhortation to you,—that within the whole range of your several spheres, according to the best of your abilities, you should promote the united cause of a free conscience and an universal education.

WATER.

In treating of a substance so common as water, it may be expected, that we shall not have to use many uncommon words. Wherever this is necessary, we shall endeavour to explain them, as they occur, in such a way as to remove any difficulty which they might occasion.

Water is not a simple substance: it is composed of two gases or airs—oxygen and hydrogen—united in the proportion of eight to one in weight so that nine pounds of water contains eight pounds of oxygen and one pound of hydrogen, chemically combined. All matter, with which we are acquainted, is capable of existing in three forms—solid, fluid, or aëriform; and water is found under each of these forms. It is either solid, as in ice, hail, or snow; or liquid, as it is generally found in temperate or warm climates; or gaseous—that is, in the form of an invisible vapour, as in steam. Without entering into the question as to the cause of this change in the form of bodies, we may consider, that the very small particles, of which bodies are composed, are capable of being acted upon by two opposite forces. By one of these, which is called the attraction of cohesion, the particles of a body are drawn together; by the other, which is called the repulsion, they have a tendency to separate from one another. If the attractive force is the stronger, the body requires force to separate its parts,—or it is a solid; if the attractive and repulsive forces are exactly equal, the parts of the body can be separated by the least force,—or the body is a fluid; if the repulsive force is the stronger, the particles require some force to keep them near one another, the body resists compression,—or it is an air or vapour. Heat has the property of increasing the repulsive or expansive powers of the particles of bodies; and a very simple experiment will shew the manner in which water will assume the form of a solid, a fluid, or a vapour, by the influence of heat.

Suppose A, B, C, D is a closed glass vessel, containing at the bottom a small quantity of pounded ice or frozen snow, S, and that a thermometer, T, has its bulb immersed in the ice, which will, of course, mark a temperature at least as low as 32° of Fahrenheit. Suppose, also, that the cubical contents of the vessel are full 1,700 or 1,800 times as great as those of the part occupied by the ice, S. Now, let heat be applied at the bottom, as, for instance, by a lamp, or by setting the vessel on a heated plate, and observe what takes place.

If the temperature of the ice is below the freezing point, or 32°, the mercury in the thermometer first rises to that point, and then the ice begins to melt. During the time of melting, the temperature, as indicated by the thermometer, does not rise at all. The mercury still stands at the freezing point till every particle of the ice is melted. The mercury in the thermometer then begins to rise until it reaches 212°, the boiling point of water. Before that time, bubbles will be observed rising in the water; and as soon as the water boils and begins to be converted into steam, the temperature, as indicated by the thermometer, again ceases to increase; the mercury is stationary at the boiling point, until the whole of the water has disappeared.

Thus *the addition of heat* to the solid body, ice, has changed it into a fluid, and the addition of more heat has changed the fluid into a vapour; so that we may say, without much impropriety, that heat and ice together produce water, and water and heat produce steam.

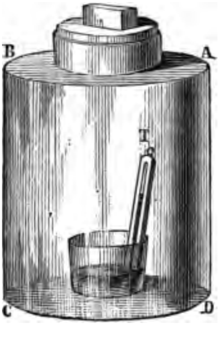


Fig. 1.

If the vessel be suspended during the experiment, and balanced by a weight, it will be found to have neither gained nor lost any weight,—which shews that the very same matter, which was first in the form of ice, and then of water, is still contained *in the* vessel, only it is converted into steam. The fact may be proved by exposing the vessel again to when the very same weight of ice will again be ined as was originally placed in the vessel. Hence, very far from being a matter of course that water ld be found in a fluid state. The limits of temture, between which that condition is fulfilled are small. Had the heat of the earth been comparay but little less than it is, water would have existed, rally, only as a solid substance; the ocean would been a mass of ice. Had the heat of the earth much greater, every drop of water would have dissipated into vapour.

iere is another very remarkable circumstance cond with the communication of heat to water. All are expanded by the addition of heat; and we already seen that this property, in mercury, enables measure the quantity of sensible heat by the e of expansion. If mercury be gradually heated, itinues to expand very nearly equally, till it reaches nperature of 660° of Fahrenheit, and boils.

her fluids expand also, although not so equally, by ddition of heat, and contract by being d; but in water there is a striking ation from this otherwise general law. ose a large thermometer-tube, A T, to been filled with boiling distilled water, then hermetically sealed, or closed by s of the blow-pipe, at A, and that, at emperature of 60°, the water stands at oint marked in the figure. If the bulb w plunged into a freezing mixture, the will be observed to contract, until it ttained a temperature o. about 40°. the degree of coolness has been reached, rater will be observed to rise again in ube, indicating an expansion in the fluid, just below it is cooled down to the ng point, 32°, it stands at the same t as it did at the temperature of 48°.

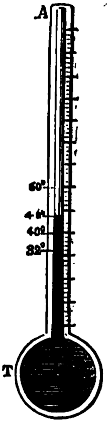


Fig. 2.

the act of freezing, water expands with great rapidity, and if confined, with irresistible force. Every one must have had experience of the breaking of a bottle, or other vessel, by the freezing of water in it; and an iron bombshell has been burst by the same means.

The Florentine academicians succeeded in bursting a brass globe, the cavity of which was an inch in diameter, by filling it with water and freezing it. The force necessary to produce this effect was calculated at 27,720 lbs. The quantity of expansion is such, that eight cubic inches of water form about nine cubic inches of ice.

The deviation from the ordinary law of expansion in the case of water is a fact of immense importance. If water continued to be compressed until it froze, as in the case of other liquids, large bodies of water, instead of being covered with a coating of ice, would be converted into solid masses; a state which would destroy the existence of almost all living creatures, which now pass the winter under water in security and comfort. The cold, which congeals water, is usually applied at the top: as soon as a small quantity of water is cooled, it becomes specifically heavier than the rest, and sinks, thereby exposing a fresh surface to the action of the atmosphere. Thus a constant current is kept up, the cooler water descending, and the warmer ascending, until the whole reaches the temperature of 40° (or 8° less than freezing). After this point, the cooler stratum of water at the surface expands, and becomes specifically lighter than that below; it therefore floats, and so continues, until a sheet of ice is formed at the top, while the temperature of the water below may be seven or eight degrees warmer,—a degree of heat quite sufficient for fish and other water animals.—*S. M.*

BRITISH FREEDOM.

IT is not to be thought of that the Flood
Of British Freedom which to the open sea
Of the world's praise from dark antiquity
Hath flowed, " with pomp of waters, unwithstood,"
Roused though it be full often to a mood
Which spurns the check of salutary bands
That this most famous stream, in bogs and sands
Should perish, and to evil and to good
Be lost for ever. In our halls is hung
Armoury of the invincible knights of old
We must be free or die, who speak the tongue
That Shakespeare spake, the faith and morals hold
Which Milton held. In every thing we are sprung
Of Earth's first blood—have titles manifold.

—*Wordsworth.*

THE LEVEL SURFACES OF LIQUIDS.

THERE is not presented to us in the whole range of our experience any instance of a level surface more perfect than the gentle surface of a liquid. A still lake or pond, or the water in our cisterns and water-jugs, are all equally level at the surface. They require none of man's agency to make them so, for they become so whether he wills it or not. We take advantage of this property to assist us in determining the level of a piece of ground in surveying. A bubble of air is enclosed in a tube, containing a liquid; and the surveyor places thy tube horizontally, and knows when it is quite level be observing that the bubble of air is in the middle of the length of the tube. The liquid has then no tendency to drive the air bubble in one direction more than another, and therefore the bubble remains in the middle, from which circumstance the surveyor knows that any piece of wood or other surface on which the tube is resting is level. This tube he calls a spirit level. The liquid employed in the tube is usually coloured spirit, because pure spirit, or alcohol, is never frozen, however great the cold may be to which it is exposed.

The reason of this perfect level to which the surface of a liquid attains, is that liquids, like every other body, tend towards the centre of the earth; and that as the particles of water move freely among themselves, any unequal pressure is soon communicated to surrounding parts. Suppose now that we had a large cistern of water, and that the surface of the water were three or four inches higher near one end of the cistern than near the other, there would be a larger amount of water, a greater number of particles pressing on the bottom of the cistern at the former part than at the latter. Each particle presses on that which is beneath it; and as there would be a loftier column of particles at the one part of the cistern than at another, those particles which are near the bottom of the heavier column would press on those that surround them, and force them upwards, in order in fact, to allow room for themselves to escape from some of the pressure which they experience. There continues to be this pressure until the surface is level in every part, when, as all parts of the liquid near the bottom are equally pressed, no one can yield to another, and they all remain in equilibrium (a word which means equally balanced). It appears, therefore, that as soon as the surface of the liquid becomes, from any cause, out of the level direction, a commotion and a kind of a struggle takes place, and does not cease until the level is again attained. There is a very good experiment which shews this tendency of liquids to maintain a perfect lovel, and to descend whenever an opportunity offers for so doing.

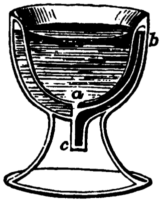


Fig. 1.

Fig. 1 represents the section of a vessel or basin, which exhibits the paradoxical property of never becoming full, however much water may be poured into it. The vessel looks neither like a sieve nor a cullender*; no holes can be seen in it, and no water is seen to flow from it. A little inspection of the construction will, however, enable us to solve this riddle. It may be seen that the vessel is sufficiently thick to have a groove or channel cut in it. At the bottom of the vessel, at *a*, there is a small opening, which leads into a channel ascending to the point *b*, and from thence descending to the point *c*, where it is enclosed in the foot or stand of the vessel, which is hollow. Now, when water is poured into this vessel, some of it enters the little channel at *a*, and ascends as fast as more water is poured into the vessel; just before the vessel is quite full, the water ascends to that part of the channel which begins to turn downwards, and immediately on attaining that level, the water flows down the outer channel as fast as it is poured into the vessel, provided that is not done too quickly. There is a conveyance for carrying off the water from the lower cistern at *c*, by a concealed pipe, not shewn in the figure.

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* More correctly spelt *colander*.

Here, then, we have an instance of the tendency of water to keep a constant level, whether it branch out into two or three streams, or remain in one body. The water ascends in the narrow channel just as fast as in the broad open part of the vessel; and when it arrives at the level of the bend in the channel, instead of rising still higher in the vessel, it turns into the descending part of the channel, and so flows out.

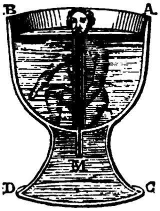


Fig. 2

This property has been made the groundwork of an amusing experiment. Fig 2 is a philosophical toy, called the *Cup of Tantalus.* A little figure of a man or boy is sitting in the cup, and his face is made to express great anxiety to obtain something to drink; but that he can never obtain. If we pour water into the cup it will rise just to the level of his chin, but no higher, and the little martyr to thirst is obliged to keep his lips dry, whether he will or no. The mystery is ingenious, and is very similar to the experiment which we last described.

A double tube passes through the body of the figure, having an ascending part, whose mouth is within the cup, and communicating with the water; and a descending part, whose mouth M, is concealed in the hollow, D C, of the vessel. When the water is poured into the vessel, it ascends the tube in the interior of the figure; but as the tube bends downwards when it reaches the level of the chin of the figure, no sooner does the water in the vessel reach that level than it begins to descend the tube to M, and so escapes, leaving the head of the figure quite untouched by the water. The tube in the figure being very small, its course cannot well be traced; but the subjoined figure (fig. 3) will shew the principle more clearly. The shorter leg of the bent tube is open to the water, and when the latter ascends to the level of the bend in the tube it flows over that bend, and escapes at the exterior mouth of the tube.—*S. M.*

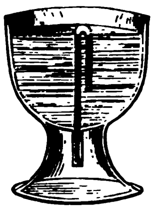


Fig. 3.

THE FLAME OF A CANDLE.

Part I.

What a pretty invention is a candle, especially a wax or a composite candle! So beautifully white, so truly rounded, and so nicely moulded into a point round the top of the wick!

I could give you a good deal of curious and useful information about the manufacture of so simple an article as a candle; but I am now going to burn it, and to shew you a little of the chemistry of its flame. Let us light the candle, then. See how steadily the flame ascends, sharp and pointed, like a spear or arrow-head. Why does the flame take this form?—why might it not be round, square, or oval, or any other shape?

I will tell you why. A candle cannot burn without air, any more than you can live without air. If you wish for a proof that air feeds the flame of the candle, we can easily make an experiment.

A short bit of candle will do best for our purpose, about an inch long, lighted and stuck upon the table. There, now, cover it over with that large tumbler, quite over, so that the edge of the glass rests upon the table. Look how dim the flame grows—yet dimmer; it flutters, it dies! Why, it did not last for a quarter of a minute! No, nor anything like it; for if the tumbler held a full quart instead of about half-a-pint, the flame would scarcely have lasted fifteen seconds. I know this, because I have tried the experiment before.

The flame goes out because it is in a confined portion of air, and the glass being close upon the table prevents any fresh air from getting in to supply the flame. But, see! the other candle burns on freely, because it can get a proper supply of air from all parts of the room; but if you stopped up the fire-place, windows, key-holes, and every crack or crevice in the room, this candle would go out just the same as that under the glass did just now, only it would be a longer time doing so, because it is in a larger portion of confined air. But as the air always rushes into a room through the crevices of the doors and windows, the candle always gets as much as it wants.

Hold the lighted candle opposite the key-hole of the door. There, see how the flame is blown towards you by the air whistling through the key-hole.

Well, then, the air comes about the candle to support the flame, and after it has done so, and got very hot, it ascends towards the ceiling; more air comes forward to supply its place, and so on during the whole time that the candle burns. So you see the flame is placed in the centre of an ascending draught of air, which urges it upwards into a sharp and pointed form. Chemists find that the quiet of the air is disturbed by the heat of the flame, that the hot air is lighter than colder, and that, therefore, the flame is unequally pressed upon.

The pressure is stronger at the lower part, weakest towards the upper part, and, therefore, the pointed form results from this unequal pressure. The flame would be as round as a marble if it could burn without disturbing the air, because then it would be equally pressed upon from all sides at once. There are methods of shewing this form of flame; but these I do not think you would be able to understand yet, and I am sure you could not put them into practice.

Look at the beautiful devices lighted with gas during public illuminations; there the gas flames, although for the most part forced out in a straight direction, bend upwards, to assume their natural position. This pointed form of flame attracted the attention of the old chemists, and in many of their curious books, instead of writing the word *flame*, or *fire*, they put a mark or sign for it, shaped like this, △,—no bad representation of the form of a flame; and as *water* was the element opposed to fire, they reversed the mark or sign for it like this, ▽; these sorts of signs were used to prevent people from understanding their curious works.

Well, then, the ascent of air towards the flame is the cause of its pointed form. But now observe how nicely the melted wax remains around the wick, confined in a sort of little cup. But why should not all the wax melt and run into a mass by the heat of the flame? Why does only that portion melt which is close to the flame, and why is it there held in this regularly shaped cup?

I will endeavour to explain why, as familiarly as I can; for it is a very beautiful process, and depends upon the air. See, now, the flame melts a portion of the wax; very well, the air immediately rushing upwards, as I have just told you, cools and keeps cool the wax around the outside of the candle, forming, in fact, a little circular wall, within which, as within a cup, the melted wax nearest the flame is safely kept. If I destroy this cup, I instantly spoil the burning of the candle. I will hold this red-hot poker near it, so as to melt down the wall of the cup. There, now, it melts away; and look, the flame cannot get its proper supply of fuel, for the melted wax runs away from the wick, and "gutters" all down the candle.

How beautifully and how effectually, then, does the air act round a candle, not only supporting its flame, but also supporting its melted fuel. If the air could not keep the outside of the candle cold, and thus form a cup, a candle would burn very badly, and would be of very little use.

I was at a great public meeting, in a large room, the other night, and there were five or six hundred candles burning, but not steadily. They were running and guttering, although of the very best manufacture. How was this? Why, the company and the flames of the candles had heated the air of the room so much, that it was hot enough to melt down the walls of each candle-cup, and therefore they could not burn properly. In the chandelier holding two or three rows of candles, the upper rows were burning languidly, and guttering away; the bottom rows were burning better, but not well. How was this? Why, they were getting the most benefit of the air, and sending it up hot and vitiated to the rows above them. You never see the branches on a chandelier set exactly over each other, but alternately, so that the hot air from the lowest row may ascend without annoying the rows above it; and this answers very well for two rows; but when there are five or six, and the chandelier is hung near the ceiling of the room, the guttering and destruction of the candles is unavoidable.

The candles on the table in a hot room burn better than those in the branches around the walls, or in the chandelier at the ceiling, because they are in a cooler situation.

The wick now requires notice. Why does it raise the melted wax from the cup and deliver it to be burnt in the flame? I will tell you. The wick possesses a peculiar power, called *capillary attraction;* I mean by this term, the rise of fluids in very small tubes,—yes, even in tubes or pipes as fine as a hair. But I will make an experiment to illustrate my meaning. There is a bit of cane, about an inch long; see, it is full of small holes; I can easily blow through it. Well, there is no difficulty in calling these holes very small tubes. Look, then, I just put the bit of cane so as to touch the surface of the water in this tea-cup. Wait a moment; and now some of the water has risen through the small holes in the cane; it is quite wet on the upper part. There is another bit of cane, and there is a tea-spoonful of turpentine; I will make a similar experiment with it. Now the turpentine has risen, and I will light it; but as it burns with a good deal of smoke, put it on the hob of the grate, that we may not be annoyed. Look now, all the turpentine is drawn out of the spoon and all burnt. But you ask me where are these little tubes in the wick of a candle? You can easily imagine that the cotton threads of the wick are laid side by side, and therefore leave little spaces between each other. Well, then, these little spaces are the tubes, and when the wax is melted they attract it upwards, just the same as the small tubes in the cane attracted up the water or the turpentine. Thus the flame is supplied with liquid fuel, and as it is burnt, the wick becomes charred and useless, forming the "snuff" of the candle.

I will tell you about the hollow nature of the flame and its luminosity on the next occasion.—*S. M.*

FAREWELL OF THE DUKE OF BUCKINGHAM.

Buck. All good people,
You that thus far have come to pity me,
Hear what I say, and then go home and lose me.
I have this day received a traitor's judgment,
And by that name must die; yet, heaven bear witness,
And if I have a conscience, let it sink me,
Even as the axe falls, if I be not faithful!
The law I bear no malice for my death;
It has done upon the premises, but justice:

But those that sought it I could wish more Christians;
Be what they will, I heartily forgive them:
Yet let them look they glory not in mischief,
Nor build their evils on the graves of great men,
For then my guiltless blood must cry against them.
For further life in this world I ne'er hope,
Nor will I sue, although the king have mercies
More than I dare make faults. You few that loved me,
And dare be bold to weep for Buckingham,
His noble friends and fellows whom to leave
Is only bitter to him, only dying,
Go with me, like good angels, to my end;
And, as the long divorce of steel falls on me,
Make of your prayers one sweet sacrifice,
And lift my soul to heaven. Lead on, o' God's name.
Lovell. I do beseech your grace, for charity,
If ever any malice in your heart
Were hid against me, now to forgive me frankly.
Buck. Sir Thomas Lovell, I as free forgive you
As I would be forgiven; I forgive all;
There cannot be those numberless offences
'Gainst me, I can't take peace with: no black envy
Shall make my grave. Commend me to his grace;
And if he speak of Buckingham, pray, tell him
You met him half in heaven: my vows and prayers
Yet are the king's, and, till my soul forsake me,
Shall cry for blessings on him: may he live
Longer than I have time to tell his years!
Ever beloved and loving may his rule be!
And when old time shall lead him to his end,
Goodness and he fill up one monument!
Lovell. To the water side I must conduct your grace,
Then give my charge up to Sir Nicholas Vaux,
Who undertakes you to your end.
Vaux. Prepare there!
The Duke is coming: see the barge be ready;
And fit it with such furniture as suits
The greatness of his person.
Buck. Nay, Sir Nicholas,
Let it alone; my state now will but mock me.

When I came hither I was Lord High Constable
And Duke of Buckingham; now poor Edward Bohun.
Yet I am richer than my base accusers,
That never knew what truth meant: I now seal it;
And with that blood will make them one day groan for 't.
My noble father, Henry of Buckingham,
Who first raised head against usurping Richard,
Flying for succour to his servant, Banister,
Being distress'd, was by that wretch betrayed,
And without trial, fell; God's peace be with him!
Henry the seventh succeeding, truly pitying
My father's loss, like a most royal prince,
Restored me to my honours, and out of ruins
Made my name once more noble. Now his son,
Henry the Eighth, life, honour, name, and all
That made me happy, at one stroke has taken
For ever from the world. I had my trial,
And, must needs say, a noble one; which makes me
A little happier than my wretched father;
Yet thus far we are one in fortunes—both
Fell by our servants, by those men we loved most;
A most unnatural and faithless service!
Heaven has an end in all: yet, you that hear me,
This from a dying man receive as certain:
Where you are liberal of your loves and counsels,
Be sure you be not loose; for those you make friends,
And give your hearts to, when they once perceive
The least rub in your fortunes, fall away
Like water from ye, never found again
But where they mean to sink ye. All good people,
Pray for me! I must now forsake ye: the last hour
Of my long weary life is come upon me.
Farewell·
And when you would say something that is sad,
Speak how I fell. I have done; and God forgive me!
—*Shakespeare's Henry the Eighth.*

CAPILLARY ATTRACTION.

THE Latin word for a hair, such as the hairs of the head, is *capillus*, and a word derived from this has been applied to any tubes of which the bore is exceedingly small. When, therefore, any of our readers meet with the term capillary tube, they will understand that, although the term bears a very learned sound with it, yet it means nothing more than a fine hair-like tube. Glass tubes can be made less than one-hundredth part of an inch in diameter, and these are called capillary tubes. The term, however, is often applied to tubes considerably thicker than a hair.

Such tubes exhibit peculiar effects on liquids contained in them, and on liquids into which they are immersed. We all know that a liquid, under general circumstances, maintains a constant level at every part of its surface; and if we dip into a liquid a broad tube, open at both ends, such as a lamp-glass, the liquid will rise inside that tube to the same height as the level of the surface of the liquid outside, but no higher. These are circumstances with which we are so familiar, that we take no note of them; but when we thrust a tube of very small bore into a liquid, the liquid rises in the tube, but not always to the same height as the exterior surface of the liquid, sometimes higher, and at other times lower.

The circumstance, or the property, which leads the liquid to rise to a greater or less height, is called capillary attraction; and the four little sections in fig. 1, will serve to illustrate examples of this kind of attraction.

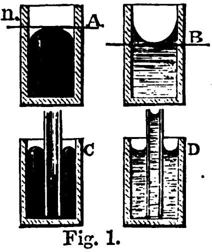


Fig. 1.

If we have two glass tubes of equal size, A and B, which are stopped at the lower ends, and if we pour mercury (that is quicksilver) into A, and water into B, we shall generally find that the surface of the mercury in A, will be round, or convex, or swelled upwards, while the surface of the water in B, will be sunken, or hollowed, or concave. Now this difference arises from the different way in which glass is affected towards the two fluids. Mercury and glass have a sort of repulsion for each other; they act as if they did not wish to come together. If we drop a little mercury on a piece of glass it will not spread like water, but will remain as a small globe of mercury, so as to touch the glass as little as possible. Now it is for that reason that the top of the mercury in the tube is *convex;* the tube drives or repels the mercury from it, so that the later is accumulated in a heap in the middle of the tube.

A line drawn across the top of the little mound of mercury shews how much it is depressed at the sides of that mound, on account of the repulsion of the glass. With the tube, B, however, it is different. Water and glass have an attraction, or, if we may use the term, a liking for each other, and the glass draws the water towards it whenever an opportunity occurs. If we drop a little water on a clean piece of glass, it does not remain in globular drops like the mercury, but spreads out, as if to gain as large a surface of contact with the glass as possible. Now such is the case in the tube. The sides of the tube draw the water towards it all round, so that the centre is deprived of some of its water, and becomes depressed or *concave.* If we draw a line across the centre of the surface of the water, we find that there is a considerable portion above the level near the sides of the tube.

Suppose, now, that the tubes were a little larger than these, and that very small, or capillary tubes, were thrust down the middle of them, C will represent the effect when mercury is the liquid employed, and D when the liquid is water. If C be partly filled with mercury before the small tube is inserted, the surface will be convex, as before described; and on immersing the small tube, mercury will ascend into it, but not to the same height as the level of the mercury in the outer tube, and the mercury in both tubes will be convex at the surface. Here then we see that mercury, in accordance with the general principles that regulate liquids, ascends the inner tube, in order to gain the same level as the mercury in the outer tube; but it receives such a check from the repulsion which the glass manifests towards it, that it cannot attain that level, but remains at a lower level, as in the figure, C. Let us now turn to D. When water is poured into this tube, and the small tube immersed in the water, the water rises to the latter, not only to the same level as in the outer tube but still higher, while the surface of the water is concave, thus shewing in two different ways an attraction between the glass and the water; for, after the water has ascended in the inner tube to the same level as in the outer, by the exercise of the ordinary property of liquids, it ascends still higher, by the attraction of the sides of the inner tube operating to draw it upwards. If the inner tube be not more than one hundredth of an inch in diameter, the water ascends in this way, by capillary attraction alone, as much as four inches.

In fig. 2, we have the same facts proved by a different mode of illustration. Let A represent water, and A B, two small balls (made of any solid material which can be wetted by water), placed upon the liquid surface, or suspended so as to touch and sink a little below such surface. When the balls are placed near each other, there will be a hollow, concave space between them, formed by the depression of the water, as shewn at A B in the figure, and resembling the concave at B and at D, in fig. 1. If now, by means of a feather, we wet the parts of the balls near the arrows, the water will flow up above the level, in the direction of the arrows, and wet the balls nearly to the top. If we move the balls nearer to each other in the direction of the arrows, the concave space between them will become more hollow.

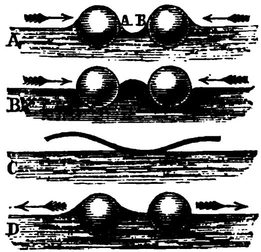


Fig. 2.

In B, fig. 2, we have mercury, into which the balls are partly depressed, and the space between them then becomes convex, as in A C, fig. 1.

If we move the two balls nearer together, the mercury between them becomes more convex.

C, fig. 2, represents the curve formed by the ball and the water; the former not being shewn in the figure, in order to give a general view of the disturbance of the liquid surface, and its elevation above the liquid level.

In D, fig. 2, we have an interesting variation of A. One ball is completely wetted, and water rises up all over it, producing a general elevation above the level of the liquid, the other ball is kept perfectly dry, by giving it a slight coating of grease or of varnish, and in this condition it repels the water around it, and produces the hollow, or depression, as shewn in the figure. If the balls be moved along in the direction of the arrows, an elevation and depression will accompany them in the same manner as if they were stationary. We see, then, that if one of the balls be kept dry, and the other allowed to get wetted, the water will rise up round the latter, and be depressed round the former. Did any of our younger readers ever consider how it is that the oil in our lamps becomes consumed? We put oil into a hollow case, and attach a wick of cotton, which partly dips into, and partly rises above the surface of the oil, but we apply a light to the wick, at some distance above the cistern of oil; how, then, does the oil ascend? We may reply, that if there were no such thing as capillary attraction, our lamps would be of no use whatever. Oil, like other fluids, has in general no tendency to ascend, and it does so in this case only on account of the peculiar attraction of which we are now speaking. The wick consists of several filaments of cotton-thread, loosely twisted together, and in this form the intervals, or *interstices*, between them act like capillary tubes, up which the oil ascends. If we put a new wick and a new supply of oil into a lamp, we shortly see the upper extremity of the wick wet with oil; for it has ascended through the little channels between the filaments of cotton. As the oil burns away in form of flame, more oil ascends through the wick, and thus a supply is kept up.

If we fill a glass tumbler with water, and put one end of a skein of thread, or of a wick of cotton, into it, and let the thread hang over the edge of the glass, so that the other end shall be outside, the glass will be entirely emptied. The little filaments carry up the water in minute streams and channels, and when it has arrived at the edge of the glass, it follows the course of the thread down the outside of the glass. If one end of a towel or handkerchief be placed in a wash-hand basin containing water, and if the towel hang over the the edge, and have the other end outside the basin, the water will be conveyed from the basin in a similar manner to that in the last experiment. The towel or the handkerchief is made of linen or silken threads, each of which is formed of a fibrous material, and the minute spaces between the fibres act as capillary tubes, and conduct the water through them. If a skein of cotton or of silk be placed partly into a glass tumbler full of water, and the other part be placed in an empty tumbler near the first, the water will flow from the first into the second glass, until it is at the same height in both.

If we take a small square of glass, and dip it edgeways into a basin of water, we shall see that the water will slightly rise at the surface of the glass, but in so small a degree as to be hardly perceptible; but if we have two squares of glass, and place them face to face, but not absolutely touching, and then dip their edges into water, we shall find that the water will rise between them to a perceptible height: we have, in fact, a broad, flat, capillary tube, up which the water ascends. But the most pleasing way of producing this result is to place the pieces of glass in contact at one of their upright edges, and to let them gradually open towards the other upright edge. The water will then ascend to different heights between the plates, being highest at that side where the glasses are in contact.

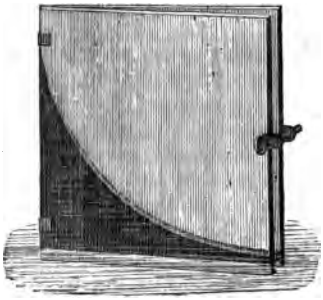


Fig. 3.

Fig. 3 may illustrate this. We have here two pieces of glass connected by hinges at the left edges, while the opposite edges are clasped by an instrument which allows us to vary the distance of the two plates: when the plates are a little opened at the edges, they are then in the condition of a book very nearly closed. If now the lower edges be dipped in water, the water will ascend to a considerable height near the hinges, and to a gradually decreasing height as we go from those edges to the edges which are a little opened. The water forms a curved line, called *hyperbola,* which is represented by the darker lines of the figure. This experiment is more pleasing and striking if coloured water be employed. For this purpose we may drop some red or black ink into the water.

The means by which we know whether or not a solid and a fluid exert this sort of attraction on one another is by observing whether the fluid wets the solid, or immersing the latter in the former, and drawing it out again. When we dip a piece of glass into water, and take it out again immediately, the glass is wetted, which is but another mode of saying that the glass has attracted the water. But if we dip the piece of glass into mercury, and take it out again, we find that the glass is not wetted; no mercury adheres to it, because mercury and glass do not attract each other. Also, if we grease the glass, water will not adhere to, or be attracted by it.

The effect of attraction and repulsion exerted in this way may be further illustrated by fig. 4. Suppose we have water in a vessel, and have plates of different substances suspended by threads; and suppose some of the plates have the property of attracting water, and others the property of repelling it. The left hand figure, A, will represent the effect of dipping into the water a plate which attracts it; the water is raised a little on each side of the plate. The next adjoining one, B, is a plate having a repulsive tendency, so that, on dipping it into the water, a depression is seen on each side of the plate.

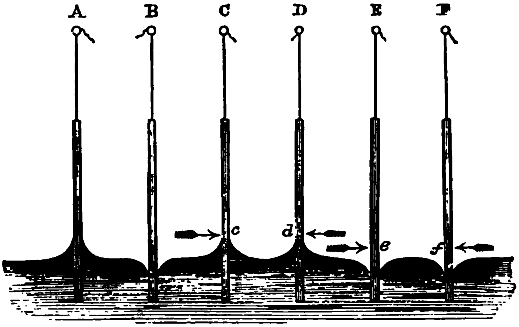


Fig. 4.

Suppose, now, that we have two plates of the former, *i.e.*, the attractive kind, and that we dip them into the water near each other, as at *c* and *d*; there is then an elevation of water on each side of each plate, and as the plates are drawn nearer together, in the direction of the arrows, the surface of the water between them gradually assumes a concave form, which becomes more decided as the plates approach each other. Lastly, if we have two plates with what we call the repulsive tendency; on dipping them in near each other, as at *e* and *f*, the liquid is depressed at those two points; and on making the plates approach each other, the surface of the water between them will become more and more convex. If two dissimilar plates, such as D and E, be used, the water will rise round one and sink round the other.

We may frequently see that, if a lump of white sugar be placed *on a wet part* of the table, the whole lump *will become wetted.* We may take a little water in a teaspoon, and place a lump of sugar in it, when we shall see the water gradually rising through the sugar, until the latter is all wetted. This is wholly caused by capillary attraction. The sugar is full of minute pores, through which the water ascends. If water coloured with red ink be employed, the experiment becomes more pleasing.

The same may be said of a sponge. If we place the lower part of a sponge in water, the whole of the sponge becomes speedily wetted, by the ascension of the water through the little channels which pervade the sponge in every direction.

If we observe the mercury in a barometer, its surface is sometimes flat, sometimes convex, and sometimes concave. It is convex when rising, concave when sinking, and flat when it has just begun to sink. These various appearances greatly influence the observer in predicting any changes in the weather. The various appearances of liquids in capillary tubes are collected in fig. 5. The first three tubes are curved at the bottom; the first tube is of unequal bore, being wider at the level *h* than in the straight part of the tube. If mercury be poured into it, the fluid will rise considerably above its level; it will rise to *a*, and form a convex surface. In the second tube, the mouth *s* is wider than the straight tube, and the latter is larger than an ordinary capillary tube. If water be poured in, it will be concave at *s*, and rise in the straight part of the tube to *s'*, where it is also concave, but if the straight part of the tube be capillary, the water will rise up to *a*, as in the third tube, and its surface will be concave. The three straight tubes represent the elevation of different liquids above the level of the liquid into which they are plunged.

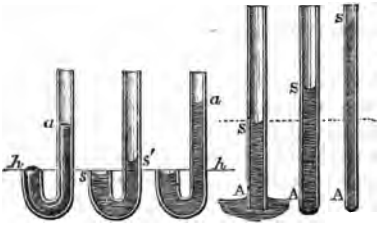


Fig. 5.

The first straight tube represents one end in water, and the level at A is raised to S in the tube; the second straight tube represents a tube lifted out of the water, and the formation of a drop of that fluid at the bottom part of the tube. This drop is formed by the attraction of gravitation, which draws all bodies down to the earth; but in this case the drop will not fall, because the capillary attraction is superior to that of gravitation. In the third straight tube the level, S, is higher than in the other cases, because the tube is supposed to be narrower.

Capillary attraction is of vast importance in nature. By its means the sap ascends the trees, and at some seasons of the year the force of the ascent is so great that if a bough be cut off from a vine, for example, and a bladder be firmly tied to the mutilated stump, it will in a few hours become full of sap, and even burst if not removed. It has been remarked that timber trees which are cut during spring or summer, when the sap is in action, yield very bad timber, which would have been good if cut in the winter; the reason probably is, that the sap decomposes, and thus injuriously affects the wood. Capillary attraction also influences the distribution of the animal fluids, and it extends its influence over mineral bodies, and greatly assists in their decomposition, and in the formation of soils. We see, then, that a small force, which is almost unnoticed and unknown by the great mass of mankind, becomes, when developed by the inquiries of science, one of the most important processes in the three kingdoms of nature.—*S. M.*

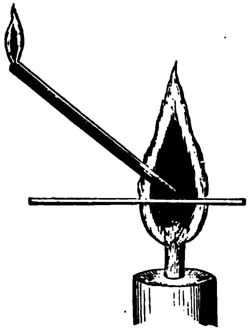
THE FLAME OF A CANDLE.

PART II.

I WILL now point out to you a very curious matter about the flame of a candle.

Let the candle burn steadily. Now, look at it attentively. Do you see that dull pointed spot in the middle of the *flame? There, j*ust above the middle of the wick. *Well, that is what I* am now going to speak about.

The vapour is burning all round the wick, but that which rises exactly over its centre does not burn, because it can get no air, the flame which envelopes it prevents any from getting in; therefore the middle of the flame remains unburnt, and gives no light, but forms a dull spot in the centre of a bright flame.



I think you will understand me better if I resort to a familiar example. Here is an almond in its shell; see how closely it resembles the pointed shape of the flame. Well, now imagine the shell to be the *outside* (the burning or light part of the flame), and the kernel to be the *inside* (the unburnt or dark part). This will give you a very correct idea of the structure of the flame of the candle; it is a sort of a natural model of it.

I can shew you, in a very decided way, that the inside or *kernel* of the flame is unburnt vapour. I take this piece of very thin window-glass. It is about four inches square. I place it thus on the point of the flame, and lower it down very quickly upon the wick. Now, look down upon the glass before it gets smoky; quick! You see a dark central spot, with a luminous ring round it.

Now, if the *whole* of the vapour of the flame was burning, there would be no dull spot in the flame, it would be equally light throughout; but, as I have just now told you, the vapour in the middle cannot burn, because of the thin shell of flame around it preventing the access of air.

In further illustration of this curious matter, I will make a very simple, yet a very pretty experiment. I will cut a little strip off this thin card, about two inches long and one-sixteenth of an inch wide; and now, when the candle burns steadily, I hold it across the flame near the wick (which, you see, I have snuffed rather short). I hold it only for an instant. I take it out. There, now look at the card, it is only scorched where the *outside* of the flame has touched it; the *inside* of the flame has had no effect upon it, because there is no fire there.

Try the experiment. Perhaps you may fail once or twice, for it requires some little dexterity, and so does the next I am about to mention; but you will be sure to succeed in both, after a few patient trials.

Here is a bit of glass-tube, about four inches long and one-eighth of an inch in the bore, it is open at both ends. I will just warm it first, by moving it gently through the flame of the candle two or three times, for perhaps it would break if too suddenly heated. This being done, I now hold it slanting upwards in the flame, so that one end may be completely in the dark part. Watch the result. Look, the unburnt vapour rises up the tube. There, now it is coming out at the top. Quick! Put a light to it, but do not agitate the air as you move your hand. See! the vapour kindles; and thus we get a second flame by leading away the inside unburnt portion of the first—a beautiful experiment.

Such, then, is the curious structure of a candle-flame, and all flames fed by a bunch of wick have dark spots in their centres. The same thing is seen in the flames of torches, links, or flambeaux, and also in the flame of coal-gas, when it is burnt at the end of a pipe, after the manner in which you so often see it blazing away in butchers' and greengrocers' shops about London.—*S. M.*

THE YOUNG CHEMIST.

I HAVE another pretty experiment, to shew you that there is no fire in the centre of the flame of a candle, and it is one that you can very easily make.

Here is half a sheet of writing-paper. I will hold it flat down upon the flame of this wax candle, so as very nearly to touch the wick, only for a moment, then take it away; now, look how the paper is scorched in the form of a ring—the shell of the flame has done this; but the paper is not a bit scorched in the middle of the ring, because there is no fire in the kernel or centre of the flame.

I now wish to tell you something about the heat of the flame. This candle has been burning for about half an hour, and it therefore has a very long "snuff." I will now blow it out with a sharp and sudden puff of breath. See, the snuff remains red-hot, and the vapour of the wax rises plentifully for a little while.

What does this prove? Why, it proves that the heat of the snuff or wick, although it is quite (nay, more than) sufficient to make the wax into vapour, yet it is not hot enough to fire the vapour so as to make flame. Whilst this wick remains red-hot and glowing, if I gently blow upon it, or still better, if I take the candle in my hand and suddenly raise it in the air, the chances are that I light it again;—look, I have succeeded! What is the reason of this? Why, the breath, or the air, has caused the wick to become much hotter than a red heat (just the same as if I blow or fan this bit of red-hot tinder, it becomes very much hotter), and this greater heat is strong enough to make the vapour catch fire and burn.

On a foggy night when the flame of a torch is accidentally blown out, if the end of the torch happens to keep red-hot, you see it easily lighted again by the link-boy whirling it quickly in the air.

I can do the same thing with this bit of stick or roll of brown paper, if I light them and let them burn a little while, then blow them out and whirl them rapidly round and round.

Look at those dying embers in the fire-grate, they are scarcely visibly red-hot; I put some fresh sticks of wood upon them, which only become scorched, not burnt, with the flame. I now use the bellows and blow gently; the embers get much hotter; now they are hot enough to kindle the vapour of the fresh wood; it bursts into flame. The same observations hold good in regard to a fire of coals.

You very frequently hear of thatched buildings, or ricks, being accidentally set on fire from the spark from a steam-engine wafted to them. The spark is not hot enough to do this immediately, but by remaining in the thatch or hay for a little while it is fanned into flame by a gentle breeze, and sad destruction of course ensues.

It must be evident to you, from these very familiar and every-day examples, that the heat necessary to produce flame is very great. See, I cannot light the candle with this dull ember. I blow upon it so as to make it hotter, and I get a light directly; a dull and red-hot cinder will not light the candle, a bright red-hot one will do so easily. In his laboratory or work room, where a furnace is almost constantly at work, the chemist is in the habit of lighting a candle or lamp with a bright red-hot coal from the fire; and when the vapour of the wax or the oil is once fairly kindled, the flame rapidly gains a little white heat by the air rushing around it, fanning it, as it were.

HEAT.

In the present state of our knowledge, it is impossible to determine whether heat should be regarded as a substance endowed with extraordinary powers, by which it penetrates and infuses itself along the particles of every other element, or as a quality inseparable from matter, and dependent on certain conditions for those unceasing fluctuations which constitute its most remarkable phenomena.

The resistless energies of this omnipotent and all-pervading agent are in constant operation. There is not an instant of time that heat is not performing some important duty in fulfilment of the Divine purposes. Among all the works of God we know of none on which the evidences of design are more conspicuously inscribed.

Whatever may be the nature of heat, be it a peculiar *substance* or a peculiar *property*, we know that it exists.

To its influence we are indebted for the due performance of all the functions of life—for all that cheers the eye, delights the ear, and gratifies the taste. Nor is it to heat only, but to its being supplied to us in due proportions, that we owe so much. Its excess or its deficiency would be equally fatal to vegetable and animal existence. In one case the earth would become a parched desert, in the other an ice bound plain.

It is important that we should distinguish between heat itself and the *sensation* of heat. The first is a cause, the second its effect. With a view to prevent mistakes by the frequent interchange of terms meaning sometimes one thing, and at other times another, the term *caloric* is now extensively employed by scientific writers to denote that condition of bodies by which the sensation of heat is produced, or, in other words, to define the *cause* of heat as distinct from its *effects*. Wishing to refrain as much as possible from scientific phraseology, we shall restrict ourselves to the ordinary term (heat), requesting our readers to remember that, unless the contrary is distinctly stated, it always means heat as an element, residing in, or operating upon matter, without any regard to our feelings.

By the continual use of the terms *heat* and *cold*, in the affairs of common life, we sometimes employ the latter term, as if it were descriptive of an element or agent, equally energetic in its effects as any other with which we are acquainted, but whose properties are directly the opposite of those possessed by heat. *Cold* is only the *absence of heat*. It is easier, (and, because we are accustomed to it,) more natural, to say, "It is cold," than it is to describe that condition by saying, "There is a deficiency of heat." The latter, however, is a correct definition. We know by experience that the gradual abstraction of heat from a body, which at first may possess so much of it as to be unapproachable, induces the sensation we denominate cold. But cold is only a relative term. We know nothing of matter where heat is not present. There is less heat in one substance than in another; but of absolute cold we have no conception.

Temperature is a term that will very often occur whilst treating of the properties of heat. We think it right at once to explain its signification. The *temperature* of a body means its sensible heat; that is, the heat of which some estimate may be formed by a thermometer, a useful instrument that we have already described.* In comparing two different substances, or two distinct parts of the same substance, if we find the first communicates to the thermometer more than the second, we say the temperature of the former is *higher* than that of the latter, or that the temperature of the latter is *lower* than that of the former. Higher and lower, as applied to temperature, are terms that evidently owe their origin to the operation of the thermometer; since the smaller the quantity of sensible heat present in any substance, with which the bulb of a thermometer is placed in contact, the lower will the column of mercury, or other fluid within the tube, descend; the greater the quantity of sensible heat, the higher will it rise. The sensible, or, as it is commonly termed, *free* heat, thus discoverable in any particular substance by the aid of a thermometer, must be viewed as entirely independent of the heat which permanently resides in that substance, or which may be temporarily combined with it in a *latent*, that is, a concealed state. We may satisfy ourselves that a vast quantity of heat has entered into some particular substance, but we can neither detect the presence nor estimate the quantity of that which is latent by our ordinary perceptions, nor through the agency of a thermometer.

Heat is communicable from one substance to another by *radiation* and by *conduction*. Radiation takes place between two bodies whose temperatures are unequal at sensible distances. Contact is a condition essential to conduction. If a piece of heated metal be fixed in the centre of a room, midway between the ceiling and the floor, heat will be disengaged from it equally in all directions, upwards, downwards, horizontally, and obliquely, which may be proved by the melting of a small quantity of tallow placed at certain distances around the metal. This is an instance of *radiation.* When the bowl of a metal spoon is left for a few minutes in a cup of hot tea, the handle of the spoon acquires the same temperature as that of the tea. Here we have an instance of *conduction.* In one case the heat separated from the metal will affect the tallow at some distance, passing readily through or among the particles of the intervening air; in the other case, the heat, first communicating with that part of the spoon in contact with the tea, is, if we may employ the expression, pushed forward from particle to particle of the metal, until it reaches its extremity.

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* See page 144.

As radiation and conduction commonly operate together, they may be considered as different parts, or rather, different forms of the same process, both equally dependent on that property, peculiar to heat, by which it tends to diffuse itself in every direction, and among the particles of every species of matter, whatever may be its form, size, colour, or quality.

Thus, if any number of vessels (some constructed of metal, others of wood, others of stone, and others of glass), each vessel containing a liquid of a different kind and at a different temperature, be placed in the same room, the liquids and the vessels containing them will, in a few hours, all arrive at the same temperature, which will be that of the air in the room. The same would, of course, be the result with solid or aëriform bodies as with liquids.

Radiation and conduction may be further explained by considering the former as operating at the surfaces of bodies, whilst the latter goes on throughout their interior parts. The rate, at which heat is radiated and conducted by any substance, depends very much on the nature of the materials of which that substance is composed. Radiation is also influenced in a remarkable degree by the colours and other conditions of the surfaces of bodies.

Those bodies into which heat enters with facility, and among whose particles it is transmitted rapidly, are called *good conductors.* Those, on the contrary, which offer considerable resistance to the progress of heat among their particles are termed *bad conductors.* The latter are frequently denominated *non-conductors,* a description not philosophically correct, since every substance with which we are acquainted will conduct heat, although in some its transmission is exceedingly slow.

Among good conductors the metals are the best; of these, gold, platinum, silver, and copper are nearly equal. The next in order are iron and zinc, then tin, and the slowest conductor of them all is lead. Wood, stone, and bricks are among the bad conductors of this class; the most perfect are wool, hair, cotton, the fur of animals, the feathers of birds, and especially the down of the swan. Liquids and aëriform bodies, when there is no motion among their particles, are bad conductors of heat. If freedom of motion be established, they become good conductors.

It is attention to this power of conduction which is our guide in the selection of clothing and building materials to suit different climates; bad conductors being selected for cold, and good conductors for warm countries.

MATTER.

By *matter* we mean the various things on this earth that we see and handle, and which we use for our own comfort. So the food we eat, the liquid we drink, the clothes we wear, and the things from which they are made, the ground we tread upon, the wood, iron, stone, brick, from which we build ourselves houses, make tools and machinery, and the coal we burn in our fire-places—all these are matter; or, as we call them, when we turn them into use, *materials*. Thus wood, stone, brick, &c., are building *materials;* wood, coal, coke, are materials for fuel; gold and silver are materials for exchange or ornament; and cotton, wool, silk, and linen are materials for clothing.

We cannot *make* matter; it is created for us, either being found in the ground *naturally*, produced by the ground naturally, or grown upon the bodies of animals, as wool, hair, &c.

And as we cannot *make* matter, so we cannot *destroy* it. I daresay you think when the coal is burnt in the grate, or a piece of paper, or an old shirt in the fire, or a candle on the table, it is destroyed. You never see it again, and cannot find it; but it is not destroyed, it is only changed into other matter. You will find some *ashes* left on the hearth after the burning, and a good deal of *soot* in the chimney, and some of the *heat* in the room and sucked into your own body, or into the water in the kettle, or the joint roasted in the oven, while some *smoke* has gone into the air outside. So the coal has only changed into ashes, soot, heat, and smoke. If I were to burn a candle in a globe containing a little lime water, this lime water at first will be quite clear, but as the candle burns it would turn muddy or milky, which shews that the candle has put something into the air in the globe that was not there before. It has really put some carbonic gas into the air, and it is this that has made the lime-water look like milk. This carbon is part of the *matter* of which the candle is composed. • If we were to weigh a candle before lighting it, and then weigh all the parts left after burning, viz., the carbon, ash, &c., we should find the weight after the burning greater than it was before. Suppose I weighed the globe and lime-water with the candle in it first, and then lighted the candle, and then weighed it again, when the burning was over, we should find the globe had gained weight. But we can no more increase matter than we can destroy it, so this additional weight is caused by the air added to, or, as we say, *combined* with, the carbon in burning.

FORCE is also indestructible. We can neither *create* force nor *destroy* it. When a blacksmith hammers a piece of iron and turns it into a horse-shoe or a flat knife, or when a railway navvy lifts a huge piece of iron with a great crowbar which he could not raise without, neither of them *creates* any force: he only expends the force in his own body; and we find that we cannot get force *without expending labour*. So it is impossible to invent perpetual motion, which some people have tried to do, for there must be something to move any mechanical contrivance, and that *something* can be traced to one source, viz., *heat*.

Now, let us see what some of the most common mechanical contrivances are, by which we seem to get a force which we cannot obtain without them.

1. An *inclined plane*. I want to get a cask of sugar or a bale of wool into a warehouse, which is three steps above the street. I cannot lift either of them; but I find I can roll them till they reach the bottom step, which bars them, and I cannot either roll them up its edge, or lift them on to its tread; but if I get a strong board, A, and lodge one end on the top step and the other on the ground, I can then roll either of them up it, but I shall have to spend more labour and take more time than when I was rolling them on the level street. So this *inclined plane*, A, has only helped me to use greater force. If I let go, when the cask is half-way up, it will not go on to the top, but will roll down to the bottom.

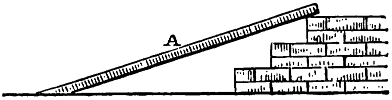


Fig. 1.

2. *Lever*. I might raise the cask one step at a time by means of a crowbar, or a beam of wood, by putting

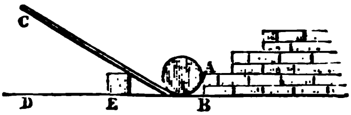


Fig. 2.

one end under it, thus (see fig. 2), and then raising the other end of the bar until I could fix a stone, E, under the bar a few inches from the cask. By pulling down the end, C, to the ground, D, I should raise the cask up one step; but you will see that I have need to expend labour enough to move the bar from C to D, in order to move the cask the little distance from B to A. So you could not lift a boy your own size very easily, but by means of a lever you do it often in play, at what is called rantipole. The plank on which two boys are seated is a lever; and it is just the same as the bar of a pair of scales where the weight in the plate hung to one end raises the sugar put into a plate hung at the other end.

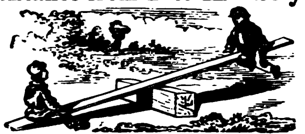


Fig. 3.

3. *Wheel and axle.* Again, I could raise the cask or bale of wool, not only up three steps, but up three stories of a warehouse, by a wheel and axle, which is a more powerful kind of lever (but it is only a lever). The lever is a bar resting on what we call a *fulcrum*, with power or force at one end, and a weight to be raised at the other. In the rantipole the fulcrum is the stone in the middle, the weight to be raised is a boy at one end, and the power, a boy at the other. In raising the cask up the step, the stone on which I rest my bar is the fulcrum; the cask is the weight to be raised; and I am the power.

Now, if I wanted to raise the cask up three stories, I might string it to one end of a rope, pass the rope over a wheel, and pull at the other end of the rope. Then my pulling at P (fig. 4) would be the power, the cask would be the weight, W, and the centre of the wheel, *a*, the fulcrum. But I should have to use very great force to raise it by this means. But if I were to wrap the

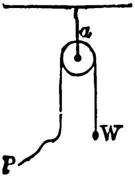


Fig. 4.

rope round the axle (as in fig. 5), and pull at an endless rope running over the circumference of a large wheel, F, I could then raise it more easily; but if 1 lb. of my weight would raise 10 lbs. of sugar in the cask for 1 inch, I must pull the rope down 10 inches to raise it that 1 inch, so that I have not really gained any force.

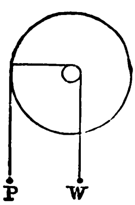


Fig. 5.

If we multiply the number of wheels or pulleys, we can lift a greater weight with smaller power. For instance, if we have *four* pulleys (as in fig. 6) we can raise the weight with one *fourth* of the power, but we shall only raise it one *fourth* of the distance; so *what we gain in power we lose in distance.*

It is on the same principle that we raise water from a well, or a large stone in a quarry. The wheel and axle in both cases are only different applications of the lever (fig. 7).

I said the ultimate source of all force was heat; but we do not *create* heat, we only transfer it from one place to another, call it out and use it.

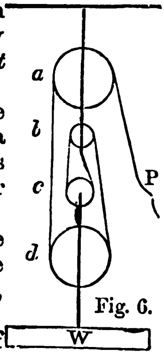


Fig. 6.

When a blacksmith hammers a piece of cold iron (as a good blacksmith can) till he has made it red-hot, by the force only of his own arm, he has transferred the heat in his own body into the cold iron and made it red-hot. So when a railway train is drawn along at great speed by a steam engine, it is the heat from the coal burning under the boiler that is the source of all this force and rapid motion. That heat is *latent* heat sucked up by the coal from the sun ages ago, when what is now coal was living vegetable matter *growing upon the* earth. It has lain concealed for

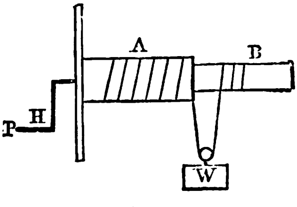


Fig. 7.

centuries, and now we call it out into activity. Supposing the grease in the box over the wheels runs short, you may see sparks flying out from the axle, and the carriage above might be set on fire, that is only the expenditure of some of the heat of the coal on the iron axle instead of its being used in drawing the train, and the speed of the train is relaxed by just so much as the waste of the heat on the axle of the wheel.

This will give you a few general ideas about force, heat, and mechanical contrivances. I shall supply you with a few more in the following lessons; but the particular details of machinery you must learn from special books on these subjects.—*Rev. J. Ridgway.*

CENTRE OF GRAVITY.

WHEN we have determined the exact spot where the centre of gravity is situated in any solid, a perpendicular line drawn from such centre to the centre of the earth is called the *line of direction;* and along this line every unsupported body endeavours to fall: if the line fall within the base of a body, such body will remain at rest; if otherwise, it will fall.

This will explain to us, why it is that a body stands firmly and steadily in proportion to the breadth of its base; and the difficulty of supporting a tall body upon its narrow base. It is not easy to balance a peg-top upon its peg; nor a hoop upon its edge; while, on the contrary, the cone and the pyramid stand firm and immovable, since the line of direction falls within the middle of the base, and the centre of gravity in such bodies is necessarily low down near the base.

All the art of a rope-dancer consists in altering his centre of gravity upon every variation of the position of his body, so as to preserve the line of direction within the base. He is assisted in this by means of a long pole, the ends of which are loaded with lead; this pole he holds across the rope, and fixes his eyes steadily upon some object near the rope, so as to detect instantly the deviation of his centre of gravity to one side or the other.

If this centre deviates for an instant to one side, he would be liable to fall off the rope on that side; but he preserves his position by lowering the end of the pole on the opposite side, and thus constantly maintains the line of direction within the very narrow base on which he stands. We frequently use our arms in the same manner as the rope-dancer uses his balancing pole. If we stumble with one foot, we extend the opposite arm. In walking along a very narrow ledge, we balance our bodies by means of our arms; a man carrying a pail of water, therefore, curves his body away from the pail, and extends the opposite arm, and thus maintains his centre of gravity in its proper position. A man carrying a sack of wheat on his back, leans forward, and thus prevents the weight from throwing the line of direction beyond the base behind him. Numerous other examples of a similar kind will readily occur to the intelligent reader. We now proceed to supply instances which are not so obvious.

In fig. 1 a weight, G, is attached to a bent wire F, and the latter is fixed at its upper extremity to a piece of wood which rests at its edge upon the table. Now, nothing more is necessary in order that the weight should fall to the ground, than that the small piece of wood should tilt over; but a careful attention to the figure will shew that, in order to overturn the board, the weight, G, must rise towards the inner part of the table; and as almost the entire weight (and subsequently the centre of gravity) of the whole, resides in the weight G, it is contrary to the law of gravitation for G to

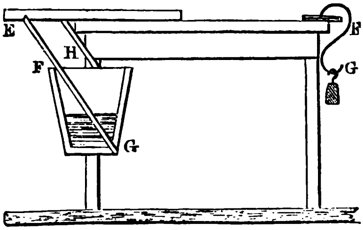


Fig. 1.

ascend, and as the board cannot upset without raising the weight, G, the whole may be made to swing to and fro without falling.

A similar fact is more strikingly shewn by suspending a pail of water, as shewn in another part of fig. 1. The pail, G, is supported by a string or handle, H, which is secured to a board or stick, rather more than half of which rests upon the table. If the pail were allowed to hang with the handle upright, the whole assemblage would, of course, upset, since the greater part of the weight would be beyond the edge of the table, and the stick is not at all fixed to the table. But the whole acquires stability by merely placing a stick, F, in the position E G. The upper end is inserted into a notch in the stick at E, while the lower end presses against the pail, and forces the handle, H, out of the vertical position. Now, no motion can be given to the pail without raising the centre of gravity of the whole arrangement, and such an elevation being contrary to the laws of gravity, the position of the pail is one of stable equilibrium, which a slight disturbance is not sufficient to destroy.

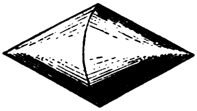


Fig. 2.

Figs. 2 to 9 are additional illustrations of the truth that the centre of gravity always seeks the lowest part. They seem, at first view, to be exceptions to the law; for a body does not naturally roll uphill, as in the following cases, but we shall find that they are as perfect illustrations of the law, as any that we have before given.

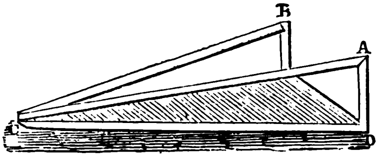


Fig. 3.

Fig. 2 is a double cone of wood, which rolls up the inclined plane A B C D, fig. 3. The sharp edge formed by the two bases of the cones is placed at C, and the cones roll to A B: but although they appear to move up the inclined plane, they actually move along a horizontal line, or down a line slightly declined, as may be seen by inspecting fig. 4, where *c e* is the line along which the cone moves; *c a* is the upward inclination of the bars of the frame, which deceive the eye in the effect produced. But *c f* is actually the path of the lowest part of the cone, and *d a* the path of the axis, both of which incline downwards.

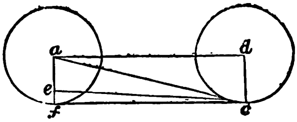


Fig. 4.

In fig. 5, the cylinder of which A K I is a section, if placed on an inclined plane, C, will roll down, because the centre of gravity not being supported in the line of direction H I D, it falls beyond the point of support, F, and the line F A does not coincide with the line of direction. But if the cylinder be not *homogeneous;* if it be formed partly of wood and partly of lead, as in figs. 6 and 7, where the shaded parts F F represent the lead, the centre of gravity is no longer the centre of magnitude of the mass, but is on one side of it as at E. Now, in fig. 7, the point of support is D, and a perpendicular from the centre of gravity, E, falls above the point of support, so that the cylinder rolls upwards until it falls to

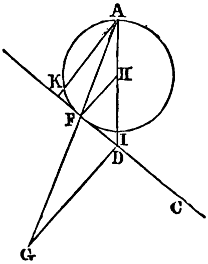


Fig. 5.

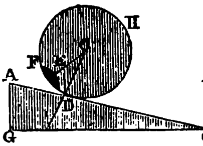


Fig. 6.

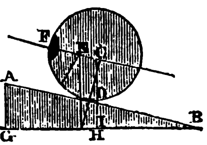


Fig. 7.

the position shewn in fig. 6; such, that a perpendicular from the centre of gravity meets the point of contact D, when it will remain stationary, although on an inclined plane. Fig. 8 is a further illustration of this interesting experiment. The dotted line is the path of the centre of magnitude of the cylinder up hill; but the curved-line is the path of the centre of gravity, so that it will readily be seen that the cylinder has a tendency to roll a short distance upwards, in order that the centre of gravity may assume the lowest possible position whereby stability is acquired.

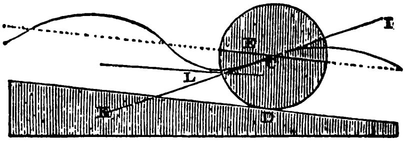


Fig. 8.

The same principle has been applied to make a watch shew time by rolling slowly down an inclined plane.

Fig. 9 is the section of a cylinder, which would roll down the inclined plane quickly but for a heavy body, P, which is so adjusted that the cylinder turns round once in twelve hours, while the weight, P, maintains a constant direction with respect to the axis of the cylinder; so that the wheel to whose axis it is attached does not move round, but allows the cylinder to move round it. The *other* wheels are under the control of the central wheel,

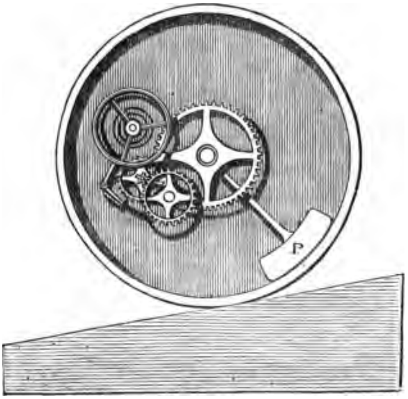


Fig. 9.

and act the usual parts of clock-work. On one end of the cylinder is a clock-face, the hands to which are attached to the axis of the central wheel.—*S. M.*

THE PHILOSOPHY OF A PEG-TOP.

We trust that our young readers will not be disposed to spin their tops with less zest when we assure them that this toy presents a very difficult problem to the natural philosopher; that the theory of its motions has engaged the attention of very eminent men; and that the questions arising therefrom are by no means satisfactorily answered. The boy who loves his peg-top because it is an ingenious toy, will, we hope, be taught by the present article to regard it with a higher degree of interest; and the man (if such there be) who despises the peg-top, because it is a toy, will have an opportunity of learning, that much philosophy may be gathered from childish things. The simple contrivance, whereby a top is set spinning, need not be particularly described. The string which is wound round the top, and suddenly uncoiled with a jerking kind of action, has the effect of imparting circular motion to the top. Now, circular motion is always the result of two forces, one of which attracts the body to the centre around which it moves, and hence is called the *centripetal* force; and the other impels it to move off in a right line from the centre, and this constitutes the *centrifugal* force. In all circular motion, these two forces constantly balance each other: if it were not so, the revolving body must evidently approach the centre of motion or recede from it, according as one or the other force prevailed. This is well illustrated by the action of a sling. When a stone is whirled round in the sling, a projectile force is imparted to the stone; but it is prevented from flying off on account of the counteracting or centripetal force of the string; the moment, however, that the string is unloosed, the stone ceases to move in a circle, but darts off in a right line; because, being released from confinement to the fixed or central point, it is acted on by one force only, which always produces motion in a right line.

We need scarcely inform our young reader that it is impossible for him to set up his top, so that it shall stand steadily on its point without spinning it. He can never keep the line of direction within its narrow base: but when the rotating motion is once established, there is no difficulty in preserving it for a time in its position. Why is this? When a top is spinning, we have an example of circular motion round a central axis; and the more rapidly the top spins, the greater is the tendency of all its parts to recede from the axis; or, in other words, the greater is the centrifugal force: the parts which thus revolve may be regarded as so many powers acting in a direction perpendicular to the axis; but as these parts are all equal, and as they pass with great rapidity round the axis, the top is in equilibrio on the end of its axis, or point of support, and thus its erect position is maintained. But the top soon falls, on account of two great impediments to its motion,—viz., the friction of the peg on the ground, and the resistance of the air. If the top could be made to revolve on a point without friction, and in a vacuum, it would continue to revolve for ever, and always maintain the same position. But, as it is impossible to comply with these two conditions, let us see what results have followed the attempts to reduce the retarding forces as much as possible.

About the middle of the last century Mr. Serson contrived a top, which, instead of the usual pear-shape of the common peg-top, presented a horizontal surface similar to what we should obtain by piercing the centre of a disk of wood (or a trencher), with an axis or peg. The upper surface of this top was polished, and it presented, while spinning, a true horizontal plane. It continued to spin for thirty-five minutes. On being spun (after the manner of spinning a humming-top), on the table of an air-pump, it was covered with a glass receiver, from which the air was then removed, and the top continued to spin during the space of two hours and sixteen minutes.

Mr. Roberts, of Manchester, a few years ago made a top which would spin in the air forty-two minutes. He made another, and, in order to give it a neat appearance, covered it with lacquer; when he found it would not spin more than seventeen minutes. He removed the lacquer, and the top continued to spin as at first. He found that the lacquer, although it improves the appearance of surfaces, yet imparts to them a vast number of minute roughnesses, scarcely, if at all, appreciable by the touch, yet sufficient to offer so much additional resistance to motion in the air.

We will now return to the common form of the peg-top, and endeavour to explain the means by which the top is enabled to rise from the oblique position (which it always assumes more or less when first set spinning), into the truly vertical position, which produces the effect called *sleeping*, when the motion is so steady that it scarcely seems to move.

When the top is *sleeping*, its centre of gravity is situated perpendicularly over its point of support; but in rising from an oblique to a vertical position, the top must have its centre of gravity raised. The force which effects this change has been a subject of contest in the philosophy of the peg-top, and we believe that Dr. Paris was the first to offer a satisfactory explanation of it. He considers it to depend upon the form of the extremity of the peg, and not upon any simple effect connected with the rotating or centrifugal force of the top. If the peg were to terminate in a fine (that is to say, in a mathematical) point, the top could never raise itself.

Let A B C (fig. 1.) be a top spinning in an oblique *position, having* the end of the peg, C, on which it spins, brought to a point. It will continue to spin in the direction in which it reaches the ground, without the least tendency to rise into a more vertical position and it is by its rotating force that it is kept in this original position; for, if we conceive the top divided into two equal parts (A and B), by a plane passing through the line X C, and suppose that at any moment during its spinning the connection between those two parts were suddenly dissolved, then would any point in the part, A, fly off with the given force in the direction of the tangent, and any corresponding point in the part B, with an equal force in an opposite direction. While, therefore, these two parts remain connected together during the spinning of the top, these two equal and opposite forces, A and B, will balance each other, and the top will continue to spin on its original axis. Hence the rotating or centrifugal force can never make the top rise from an oblique to a vertical position.

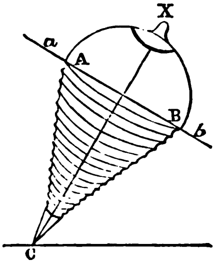


Fig. 1.

But in order to be satisfied that the change in position depends on the bluntness of the point, let A B C (fig. 2.), be a top spinning in an oblique position terminating in a very short point with a hemispherical shoulder P a M. It is evident that in this case, the top will not spin upon a, the end of the true axis, X a, but upon O, a point in the circle P M, to which the floor I F is a tangent. Instead, therefore, of revolving upon a fixed and stationary point, the *top will* roll round upon the small circle P M,

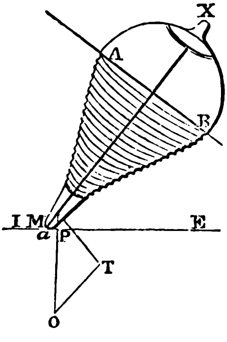


Fig. 2.

on its blunt point, with very considerable friction. the force of which may be represented by a line, O P, at right angles to the floor I F, and to the spherical end of the peg of the top. Now, it is the action of this force, by its pressure on one side of the blunt point of the top, which causes it to rise in a vertical direction. Produce the line O P, till it meets the axis C; from the point C draw the line C T perpendicular to the axis *a* X, and T O parallel to it; and then, by a resolution of forces the line T C will represent the part of the friction which presses at right angles to the axis, so as gradually to raise it in a vertical position, in which operation the circle P M gradually diminishes, by the approach of the point P to *a*, as the axis becomes more perpendicular, and vanishes when the point P coincides with the point *a*, that is to say, when the top has arrived at its vertical position, where it will continue to sleep without much friction or any other disturbing force, until its voluntary motion fails, and its side is brought to the earth by the force of gravity. —*S. M.*

THE PUMP.

EVERY boy knows what a squirt is, and how it is used. You pull up a rod by a ring at the top, hold the nose in water, and then raising the squirt, push the rod down, and the water is forced out in a stream. Now, let us look into the squirt and see how this is done. I have cut a squirt straight down from the top to the bottom, that you can see how it works. The rod that moves up and down is called a "*piston-rod*," because it works a round sort of button, called a *piston*, fixed on the bottom of it, and covered with thread so as to make it fit tightly to the sides of the barrel, and keep the air from passing between it and the barrel (or, as it is properly called, the *cylinder*). When you put the nose of the pipe into a bucket of water, no air can get in through

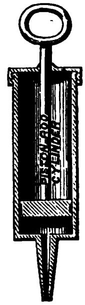


Fig. 1.

the opening, because the water closes the entrance; and as soon as you pull up the handle you leave the barrel empty of air, or cause what is called a *vacuum*. But as the air is pressing with great weight upon the surface of the water in the bucket, it pushes it up into the vacuum, till it is filled. You can easily try for yourselves how water will be forced up to fill a vacuum. Take a common tea saucer and fill it with water, and then get an empty tumbler; put a little bit of lighted paper into it, and turn it gently upside down with its mouth into the water, and you will see the water run up into the tumbler till it is nearly full; because you have burnt up most of the air in the tumbler and made a vacuum.

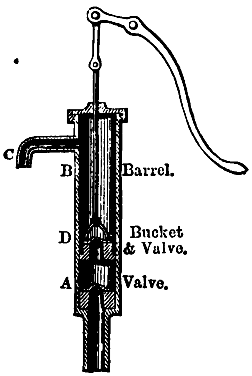
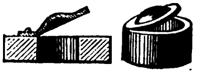


Fig. 2.



Open Valve.

Fig. 3.

A pump is on the same principle. There is a piston and a piston-rod; the air is drawn out of it, a vacuum is made, and the water rushes up into the barrel or cylinder. But a pump is too heavy to be lifted out of the water each time to squirt it out, and it would be a great waste of time, if we could do so. Another contrivance is made, then, to send the water out of the *top* part of the barrel without letting in the air, and this is by means of valves. Let us put one of these valves into our squirt, just where the pipe of the nose goes out of the barrel. You see it fits like a cork into the neck of a bottle, and keeps any air or water that gets into the barrel from running down into the pipe. At the point A there is a hinge, so that this valve can open upwards like the lid of a box, but it cannot open downwards (fig. 3). Now, if we pull up the piston-rod, the water rushes up, raises the valve, and fills the barrel. *But how* are we to get it out? We might put a pipe into the barrel at B, and then, when the piston got above B, the water would run out, but only in a very small quantity, because air would come in at the spout and the water would stop rising in the barrel; so we make a spout higher up, *above the piston,* at C.

We must now see the way in which the water gets above the piston. There is a valve again *in the piston*, and this valve only opens upwards. As soon as the piston has been drawn to the top, and the barrel below it is filled with water, we push the piston down again, and the pressure of water shuts the lower valve A, and as the piston goes down it forces up the valve in the bucket, D, (fig. 2), and the water rises into the upper part of the barrel. We now pull the bucket up again, and a fresh lot of water rushes in below; but the weight of water above shuts down the valve in the bucket, and so it is raised as the bucket ascends, until it flows out of the spout. This will be easily seen by the two figures at the side. In fig. 5 the water has been raised by the first lifting of the piston to the top of the barrel. The bucket is now descending for some more, and the water below it is rising through the valve, A, into the upper part of the barrel, the pressure of the water closing the valve B. We now raise the bucket again by another stroke of the handle, water

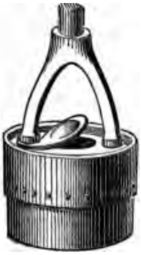


Fig. 4.

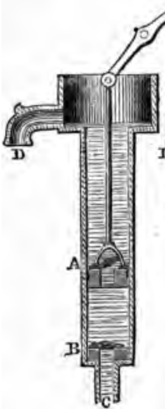


Fig. 5.

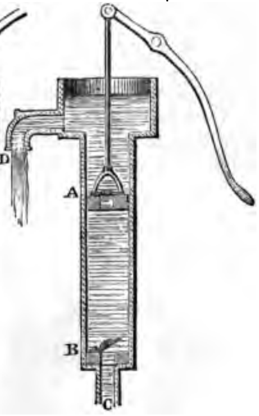


Fig. 6.

rushes up the pipe C, (fig. 6), forces the valve B open, and fills the barrel between A and B, and as the water above A keeps the valve A shut down, the water is lifted by the piston till it flows out at the spout D. As a pump is larger than a squirt, and the water raised by it is much heavier than that raised by a squirt, we could not readily pump by standing on it and pulling the piston-rod straight up by a ring at the top, and therefore we have to make use of a lever, in the shape of a pump-handle, which prizes up the piston when we throw our weight upon the piston and press the handle down.—*Rev. J. Ridgway.*

THE STEAM ENGINE.

After our lesson on the pump we shall be able to understand a little about the steam engine. We must go back again to our old friend, the squirt, which you will remember I told you was made up of a cylinder, with a piston fitting tight into it, and worked up and down the cylinder by a piston-rod. You know that you work this piston up and down the cylinder by pulling the ring at the top with your finger, and then pressing it down; but we want now to see how we can work it up and down without touching it.

You have seen a kettle, when the water in it boils, how the steam rushes out of the spout and makes the lid dance about; and the steam comes frothing out all round it. If we were to put a cork into the spout of a boiling kettle full of water, the steam would blow the lid quite off by the force of the steam. Suppose we cork up the spout, and, instead of the lid, fix a large cork bung into the top of the kettle, and then, through a hole bored in this bung, push down the nose of the squirt, what will happen? Why, the force of steam will push the piston of the squirt quite up to

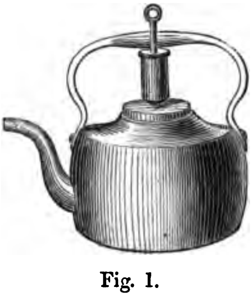


Fig. 1.

the top (just as it would force the lid off), and if you do not pull it out quickly, it will either blow out the bung or burst the kettle. So you see what force steam has.

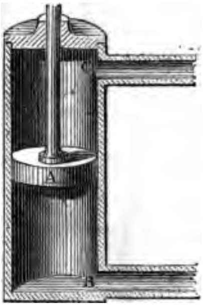


Fig. 2.

But we want to get the piston pushed down again; and if we cut off the nose at the bottom of the squirt, and fix in a flat bottom with an opening at the side, B, we can let in the steam to raise the piston, A, and then, by putting a pipe into it at the top, C, admit steam above to push the piston down again. Now, this would work very well *once*, but then the cylinder would be full of steam, and, as soon as we let fresh steam in, it would burst; so we must have some contrivance to let the steam out, as soon as it has pushed up the piston, and let it out again when it has thrust it down. This is managed without putting any more pipes into the cylinder, and we have only to carry on our drawing of the squirt in the last figure, to see how these two pipes are made so as to both let the steam in and let it out again. But as we have cut off the nose of the squirt we cannot push it through the bung at the top of the kettle, so we must put it at the side, and as we do not want the kettle spout we will cut it off, bung up the hole, and insert a pipe, D, into the lid so as to get the most steam, (as steam always rises to the top). A look at the figure above will explain how the steam is made to do its work, and then go off to play. We have our kettle on the fire and the squirt at its side. These are now the boiler and cylinder of a steam engine. As soon as the water boils, the steam rushes up the pipe D, descends to B, in the direction of the arrows, and pushes up the piston, A, till it gets to the dotted line F. As soon as it gets there, a little rod at the top of the piston turns the *stop-cock*, E (which is on the same principle as a water tap), in the opposite direction (see fig. 4), and

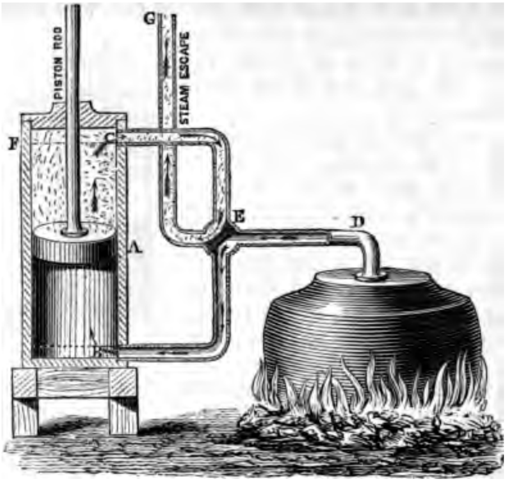


Fig. 3.

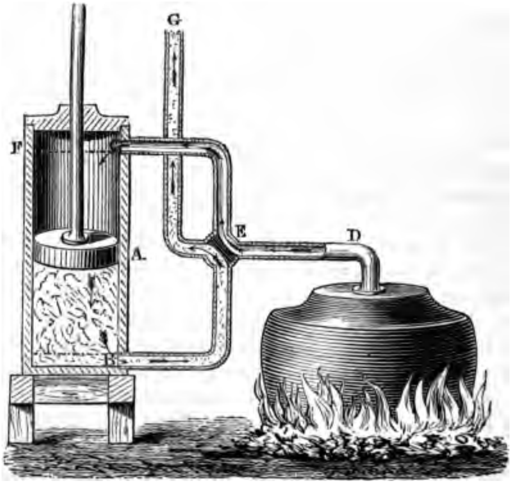


Fig. 4.

lets in the steam from the boiler above the piston at C, and pushes it down. As it descends, it forces the steam, that had raised it, *downwards*, and sends it up the pipe, B, and out of the "*steam-escape*," G. Again it turns the cock, E, which lets the steam run down the pipe, B, *under* the piston, which sends it up again, forcing the steam above it out at the pipe, C, and after going almost in a circle (see fig. 3), it escapes also by the pipe, G. If you will study each of these two figures, and follow the direction of the arrows, first in one and then the other, you will very easily understand how these two pipes first let the steam in, and then out again, by merely turning the stop-tap, E, after each admission of steam.

Well, but what is the use of all this lifting up and forcing down of the piston? How does that make an engine draw a train of carriages, or turn the machinery in a factory? We shall soon see. Every time the piston goes up it moves the piston-rod *up*, and every time it goes down it moves the piston-rod *down*; so you see we have this rod constantly kept working backwards and forwards, or up and down. I daresay you have watched a knife-grinder, or a man at a turning-lathe, working the wheel to grind the knives, or to turn the piece of wood that is to be cut. He turns the wheels above by working his foot up and down on a piece of wood (a *treadle*). Working his foot up and down is just what the steam does, and the foot and the steam both work a straight piece of iron (a piston-rod) up and down. Let us see what it is like in a knife-grinding machine. The treadle, A, pressed down by the foot, moves the piston-rod, B. The hook at the end fits on to a loop in another iron bar, which is the axle of a wheel. This loop is called a *crank*, C, and every pressure of the foot *pulls the* crank down; and, letting it go,

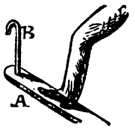


Fig. 5.

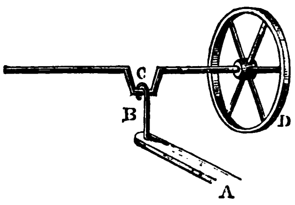


Fig. 6.

swings it up again by the impetus of the wheel, D, at the end of the axle. This wheel is called the *fly-wheel*, which in a factory is very large, so as to get a great impetus, and it is by the whirling round of this great wheel that all the machinery is kept working.

The way in which the piston-rod works the crank will be seen by fig. 7. Attached to the end of the rod is a piece of iron, shaped like the letter T, the two little drop pieces falling from the top bar of the T being lengthened below the bottom of the centre line. These side pieces are attached, one to the fly-wheel, and the other to the crank of the axle, so that as it rises and falls it pulls up or presses down the wheel.

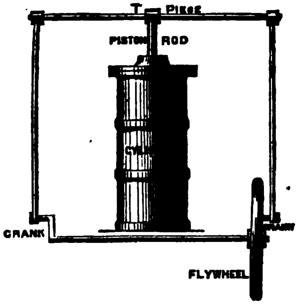


Fig. 7.

But in a locomotive engine this T-piece is attached to a wheel on each side of the engine, so that it is working two wheels at once; but those used on a railroad have generally two cylinders, one to work the wheel on one side and the other that on the other. Now, if these worked exactly together, and they happened to start with the two pistons pulling the cranks *straight* at the same time, they would not turn the wheel at all. If you watch the knife-grinder you will see he gives the wheel a spin round with his hand before he begins to use his foot, just to start it; but we cannot do so with a steam engine on account of the weight, so the two pistons work alternately, and when one is at the weakest point, where the engine has no power to turn it, the other is at the strongest, and carries the other on with it. You will see this by the figure 8. When the crank, A, is in a straight line with the piston-rod, B, it cannot turn the wheel at all; but you will see the *piston* is at the *bottom* of the cylinder, and will be soon moving upwards to push back the crank, A. It cannot do so, however, till the crank has fallen a little (as, to the dotted lines, C). Now, look at the other wheel and you will see the crank, D, is just in such a position, that the rod, E, can pull it towards the cylinder with all its might, and the piston is at the top of the cylinder, ready to go down again and pull the spoke of the wheel towards it; in doing so it will also turn the other wheel until it has got it into position for its comrade piston to push it back. Then the other wheel pulls the upper spoke of *its* wheel, while its companion pushes back the lower spoke of the corresponding one. You will now be able to understand the working of an engine, and if you look on each side of a locomotive the next time you go to a railway station, you will see these two cylinders, which I have been describing.—*Rev. J. Ridgway.*

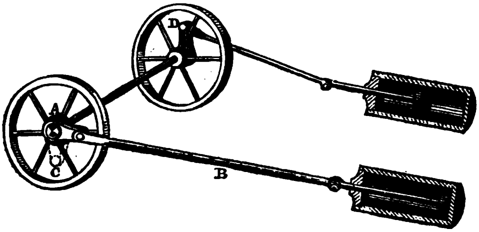


Fig. 8.

MACHINERY AT THE INTERNATIONAL EXHIBITION, 1872.

MACHINERY used in connexion with cotton and cotton fabrics, with paper, stationery, and printing, is arranged in the rooms on the ground floor of the West Galleries, in the "East Machinery Annexe," and in rooms at the south-east corner of the Exhibition. The visitor at all familiar with the manufactures, the processes of which are thus represented, will, except in the printing department, not find very much that is new to him, but those who have never been in the way of such knowledge will follow with interest the folding of an envelope, the printing of an engraving, or the winding and weaving of cotton yarn.

Beginning with the cotton machinery in Room I. of the West Galleries, we take the opportunity of turning aside to the cotton-growing house in the West Grounds, in which Major Trevor Clarke exhibits varieties of American, Asian, and African cotton. The tall, graceful plants are just coming into flower, and seem to thrive well in their pots and in a hot-house air at 95 deg. Persons inclined to take a lesson in commercial botany in such a class-room may study the similarities and differences between the several growths of Borneo, China, Assam, and India, and those of the most favoured American soils. Returning to the West Gallery, Room I. begins with 25 varieties of dried cotton in glass cases, also exhibited by Major Clarke, and with a case illustrating every stage in cotton manufactures, from the plant to the woven calico. Near at hand are samples of cotton from those South Sea Islands, which must one day be the Indies of Australia; cotton cleaned by patients in the Palermo Lunatic Asylum; cotton pods from Algeria, Egypt, Aleppo, Peru, the Bahamas, Italy, Ceylon, Trinidad, Abyssinia, Queensland, and every other soil, (whether North, South, East, or West), which nourishes the plant that not only clothes mankind, but is ready to feed the lower animals; witness "cotton-seed cake for cattle food." Turning to the machinery, we may contrast the cotton-cleaning "churkas" from India, lent by the Secretary of State, with the new machine for the same purpose exhibited by Platt Brothers.

Into Room II. we pass from cotton to paper, and the general visitor may here watch, with some gleams of intelligence, the different processes of fine art and letterpress printing, and may catch a glimpse in advance of the *Good Words'* engravings. Turning to the other side, we have the not less ingenious, if more commonplace, ruling of account books practised by Letts and Co. The blue ink runs from a saturated flannel down fluted pens set in a row, and the paper takes its lines as it is drawn quickly under these. Entering Room III., we find almost the whole of the left side occupied by John Dickinson and Co.'s envelope machinery, shewing us the complete process of envelope making, beginning at the "web," or endless roll of paper, and ending with the finished envelopes in packets. First of all, here is the paper, as it arrives from the mill in rolls, which can be made of one continuous sheet several miles long, but which, for convenience sake, are limited to a weight of 4 cwt. and a length of three-quarters of a mile. This sheet is fixed to the "cutting machine." The cutters can be altered to any size, and nothing can exceed the celerity and convenience of their action. The paper leaves them in a state too rough for writing purposes, and has next to be "glazed." This gives it the required surface, and we next see it being punched into "blanks" (the shape of an envelope open at all sides) at a small press; then comes the "gumming on the nose," which is done by girls at the rate of 40,000 an hour, or about one a second; then the stamping in relief or cameo, the black-bordering (for mourning stationery), and, finally, the folding, done at two machines which work on different principles. Man's ingenuity seems to have exhausted itself in devising machines to fold envelopes, and in this room several patents may be seen doing the same work in different modes. By the account of the makers, each is in some way the very best machine of all, and by our own observation each appears to do its work marvellously well. Messrs. Dickinson shew us also the banding of the envelopes in packets, the making of boxes for those which are black-bordered, and tell us that their machines in this room will turn out 300,000 and more finished envelopes in one day. Messrs. Goodall fold and finish envelopes, with extreme neatness and fascinating precision, in a machine which stamps the "blanks" into shape in the successive apertures of a revolving dial. Messrs. Willis chop countless playing cards into their exact width from long strips of cardboard; and Messrs. Fenner turn out from their machine sixty complete envelopes a minute. We do not know that we can give our readers a better idea how manifold and complex mechanism is made to do the work of human fingers, than by quoting the account of the working of this rapid little engine:—

"A pile of envelope blanks is placed upon a plate on the left-hand side of the machine, which may be done either when at rest or when in motion. A hollow brass tube, with the end of a peculiar shape, descends upon the envelope blanks at the side nearest to the folding-box; to the other end of the tube is attached an india-rubber pipe communicating with an air-pump, which, coming into action at this instant, causes the blank which is upon the top of the pile to attach itself to the brass tube, which, rising, carries the envelope blank with it; a pair of grippers then run forward, and, seizing the blank, carry it into its proper position over the folding-box; it is then stamped, and the gum applied in the proper places upon the two side flaps. A plunger then descends and carries the blank into the folding-box; upon the plunger rising, slides, working in the thickness of the folding-box, run in and enclose the flaps in their proper order; the bottom of the box now rises and completes the operation by pressing the envelopes against the slides; the bottom of the box then falls and allows the envelope to drop in an upright position into a trough running under the machine, when it is met by a simple contrivance, which secures the envelope with its flaps in their proper position in the trough, and as each successive envelope is placed in front of it, it gradually works along the trough, until removed by the attendant and banded."

Here also the Graphotyping Company exhibit their exceedingly ingenious method of engraving. In graphotype the artist draws with chymical ink upon a surface of prepared chalk, which has been sifted upon a zinc *plate* and compressed by hydraulic power so as to give a smooth surface. The ink is prepared so as to harden the chalk wherever it touches it; when the sketch is completed, the spaces between the lines are removed by a soft brush; the drawing, thus left in relief, is washed in a chymical solution which renders it as hard as stone; a mould is then taken, and from that again an electrotype ready for printing.

"THE WALTER" PRINTING PRESS.

THE composing and distributing machines, exhibited by Mr. Walter, call for special notice, since they are both effective and new, and likely to come into use. The distributing machine is the more remarkable, as being exceedingly simple, and yet the first instance in which such a machine has been brought to do good work. Composing machines of more or less clever construction have been from time to time patented, but the bar to their use has always been that either the type had to be distributed by hand, which necessitated the retention of a staff of compositors, or that, if distributed by a machine, the type was required to be of some special construction. The new machines work with the ordinary type, and when we say that they are now in use in *The Times* Office, and that the composing machine is worked by two boys, who can compose as fast as three highly-skilled compositors, and that the distributing machine, worked by one lad, can distribute rather faster than a highly-skilled compositor, the value and importance of this patent will be at once seen. A new invention cannot well be described without illustrations, but it will give our readers some idea of these machines if we say that in the composing machine the different letters, &c., are arranged vertically in a series of cases just of a size to hold them, and in connection with pianoforte-like keys. Before these a lad sits, and as he reads his copy so he strikes a key with his finger, upon which the letter wanted drops into its place in a groove. In this groove the type gradually forms a long line, which is pushed along the slide by means of a treadle motion, which the boy keeps up with his foot, till it falls into the hands of another boy seated with his face towards the groove. This second lad "justifies" the long line of set-up type as it moves towards him—that is, he cuts it into lengths equal to the breadth of a column of the newspaper or page of the book, and fixes it in a "form," which is then taken away and stereotyped or printed from, as the case may be. Each lad has his task smoothed by all sorts of simple and handy little mechanical contrivances, difficult to describe, but easy to manipulate; and the rate of work is as we have said.

The distributing machine, or machine for separating the type after it has been printed from, so that it may be used again, works by the same method reversed. A lad sits at a key-board, the keys of which are marked with the various letters, &c., and reads the type as each line is cut off from the "forme" and pushed up into a groove under his eyes. Striking the key corresponding to the letter he wishes to put back into its place, it slips down a groove and into a case exactly similar to that from which it fell on the key being struck in the other machine. These cases are movable, and correspond in each machine, so that, when a case of some particular letter has been filled at the distributing machine, it can be removed (an empty case being put in its stead) and placed in a rack till needed for the composing machine, when it has only to be fixed in its proper position, there to stay till emptied by repeated striking of the key which causes one of the letters it contains to fall into the proper groove.—*The Times.*

THE EXPERIMENTS WITH H.M.S. "GLATTON."

The triumphant march of progress in the matter of guns has been for the moment brought to a stand-still.

Ever since Mr. Armstrong invented his little gun—for although big at the time, it is little with what we have seen to-day—ever since the Admiralty Lords found out that against such guns they might as well build ships of paper as of wood—they have been in a state of alarm and suspense. They may be said to have begun a neck and neck race. The "Warrior" was built firstly with 4½ inches of armour and 18 of wood. A new gun soon reduced her to a position not very superior to the old line-of battle ships. Then came the "Agincourt," with an inch of iron added to the armour, and 9 inches of wood taken off. A third gun necessitated still stronger defence, and the "Bellerophon," the "Penelope," and others of that class were launched with 6-inch armour and 10 inches of wood. A fourth gun was turned out. The armament of the "Warrior" consisted entirely of 4-ton guns, considered at the time of their construction unparalleled productions. They failed to pierce her own target at 200 yards' distance; but now the 6½-ton guns would pierce that target at 500 yards, and the gun that has been fired off to-day would scatter it in all directions at a range of 4,000 yards. It seemed at one time, indeed, as if the construction of ironclads must be given up in despair, for even the "Hercules," with 10½ of iron and 10 of wood, was considered unsafe against the 25-ton gun in construction for the "Hotspur." At last, however, Sir Spencer Robinson designed the three monitors that may be considered to have brought this race to a standstill, for a larger gun than the 25-ton is not at present considered feasible for general purposes; and there is some pleasure in being able to report that, at a distance of 200 yards, closer than which it is not probable that any action would take place, the turret of the "Glatton" has perfectly withstood the mass of 600 lbs. of iron and steel that were hurled against it with a charge of 70 lbs. of powder. The turrets of the "Glatton," the "Thunderer," and the "Devastation," are constructed of 14 inches of wrought iron, 16 inches of teak, three iron plates on the inside, each ½-inch, and last of all a "thin" covering of iron to prevent bolt-heads and rivets from flying about and hurting the men that are working the guns.

A small and select party of gentlemen who are interested in these experiments, and had been invited to attend them, flocked into Weymouth and caused a temporary overflow of the somewhat limited hotel accommodation which this beautiful little town affords. The morning sun rose over the bay with rare beauty, and dispelled all the fears of sudden storms overnight that might have been entertained. The time had been so arranged that breakfast could be ordered at the decent hour of seven, the first train for Portland leaving at half-past. At the landing-stair at Portland the steam pinnaces of the "Vigilant," the "Salamander," and the "Boscawen" training ship, were in-waiting to convey the favoured holders of red, blue, and white tickets to their respective ships. The trial took place in that piece of water—whether it glories in the name of harbour we have not been able to ascertain—which is enclosed on one side by the Chisel Beach and on the other side by the breakwater. The scene here was magnificent. On the water, the surface of which presented not a ripple, and which, in its light green basalt colour, was so splendidly transparent that mountains of pebbles and whole forests of seaweed could be observed many fathoms down, on that smooth and liquid mirror lay a small fleet of steamers. There, in the centre, lay the "Salamander," a wooden frigate of the good old style, that did splendid service in the bombardment of Acre some fifty years ago. Further off, towards the fort that sullenly overlooks these extraordinary proceedings, lies the "Boscawen" training ship, rising fully 30 feet out of the water. In the olden days, when every one of Nelson's men did his duty, she must have been a most formidable antagonist, but her ports are now closed, or perchance there peeps through some square black hole the laughing face and curly head of one of our young sailors, looking the picture of health and life, such as a few years ago he *did not,* and could not, dream of in the hopeless misery of a London court. Then came the two Admiralty yachts, the "Black Eagle" and the "Vigilant," with their graceful and slender outlines, and last of all, close to the breakwater, two ugly, shapeless, surly-looking masses of gray-coloured iron, the one apparently 100 yards from the breakwater, and the other immediately in front of her. The former is the observed of all observers—the lion of the hour.

The "Glatton" lies moored at a distance of about 100 yards from the inner side of the breakwater, and the "Hotspur" immediately in front of her. It is reported that the distance between the two vessels was 200 yards, but from our point of view it scarcely looks fifty. In the meantime, while we survey all this, the steam pinnace has brought us alongside the "Salamander;" we follow the leader up the ladder, lift our hats to the captain and to the quarter-deck, and feel our tempers and temperatures immediately brought down to a pleasant level by the shade of a cool awning spread from mast to mast, and elaborate preparations for an entertainment of some kind, which smiles upon us underneath, and we cannot help remarking immediately what fine fellows surround us. Everybody had brought with him a goodly store of patience, for it was said that the arrangements would not be completed till past eleven. It was, therefore, with satisfaction that we noticed some commotion on board the two monitors, and mysterious signalling going on between the "Hotspur" and the Admiralty yachts. Presently there came from the former a sound of pipes and bugle, and we began to look out with all our might. On the stern of the "Glatton" a piece of canvas had been put up on a framework, so as to present a target marked with half-a-dozen black spots to the "Hotspur's" gun. Precisely at a quarter to ten the first shot was fired at this target. The bolt must have passed clean over, for the canvas was not touched, and the water could be seen spurting up seaward to a considerable height at the point where the iron struck it. At intervals of about twenty minutes five shots were now fired at this target, the result of which we could of course perfectly discern; but knowing nothing of the intention with which the gun was aimed, we were unable to pass an opinion upon the correctness of the shot. The "Glatton" had in the meantime been getting her steam up, and these preliminary trials evidently proving successful, a red flag was hoisted on both vessels, and a longitudinal piece of wood was erected on the "Glatton's" turret, after which every living creature was seen to mysteriously vanish through sundry holes and crevices; the bugle sounded, and off went the monster, hurling its 600 pounds in mid-air. We were told that the piece of wood had been erected on the edge of the turret, so as to mark the exact spot where the shell should strike that edge. If this be true the marker must have mistaken his bull's eye, for the turret was not touched, and the wood was taken clean away, having been hit exactly in the centre. Seven bells were about to be struck when the first real shot was fired. All glasses were directed to the turret, and at about 3 feet from the top there suddenly appeared a vicious hole, with glittering pieces of iron flying backwards in all directions. Presently came the report, and for some moments a volume of smoke hid the object from our sight. From the "Salamander" it could be plainly seen that the iron outside-coating had been thoroughly penetrated, and that a large seam appeared in the joining of the upper and second plates. The ubiquitous little pinnace, which had been very busy all this time, kindly took us in tow, and shipped us on board the "Glatton." The hole certainly was immense. The entire 14-inch plate had been cut through, the pieces of the shell which filled it remaining fixed in that position. The other part of the shell had burst, and several pieces were hurled with great violence back on to the "Hotspur," where anybody at that moment on deck would have been in great danger. The inside of the turret, which contains two 25-ton guns, was somewhat blocked up by large wooden supports, which had been knocked up against the port-holes to protect the guns from possible damage, but the damage could be easily inspected. The outer "skin" had burst open altogether, the pieces yawning with 5 or 6 feet apart. The two inner thicknesses of 1 inch each had also burst inward, though not breaking altogether, for it was only through the gash that thin pieces of timber protruded. One large nut of a screw-bolt, which must have weighed many pounds, was broken right off, with about two dozen smaller ones, and hurled to the other side of the turret. The piece where it broke off being of course glittering, induced the first inspectors to consider it the top of the Paliser shell coming through, until the mistake was discovered. The wall was not pierced at all. The iron outer part was pierced, and the shell was still hot with the tremendous resistance it encountered. The teak had been forced in, the bolts and rivets sent flying, but so much strength was left that it would have required a second shot exactly in the same place to entirely penetrate the turret. Captain Boys, of the gunnery ship "Excellent," who conducted the operations, in conjunction with Mr. Crossland, of the Council of Construction, and Mr. Eames, chief inspector of the machinery at Chatham, were of course highly pleased with the success, the turret working as smoothly by hand or steam as ever. Captain Boys was in the captain's cabin of the "Glatton" at the time of firing, and assured us, that had he not known what was happening, he would have thought a tea-tray had dropped, while several of the men testified that the shock was nothing. This contrasts very favourably with the report of an American captain on board, who said that the turret to which he belonged came under fire, and the men were temporarily converted into "howling idiots"—a phase of insanity which seems by no means exclusively the property of turrets. To what the men may have been reduced if they had been compelled to remain in the turret it would be impossible to say, but a young goat which had been left there, and had placidly taken up its position at the foot of one gun, although looking somewhat nervous about the eyes, was enabled to chew and apparently enjoy its cud. A rabbit and a fowl which had also been left did not protrude themselves on our notice; probably some of the men had been moved by compassion to usher them into a more peaceful life. They were not wounded, however, and that was all it was required to ascertain.

The second shot, fired at two, proved to be so successful that a third was found to be unnecessary. It struck the turret at the juncture with the deck, the weakest point. Indeed, from the upward direction of the penetrated holes, it would seem as if the missile had first struck the deck and turned off upwards. The spot selected was between the two ports, but the damage was even less. Inside nothing whatever could be seen of the effect, but on going lower down it was found that the base of the turret, or that part of the armour, rather, which ceases just below deck, was bulged downward. This was found to be equally the case with the first, and had they bulged a couple of inches more downward they must have jammed with the rain gutter which runs underneath it. This, however, could be cut out easily even during the action, and unless the friction was very severe, the steam-power could overcome that. On deck it was found that a few angle-irons had been smashed, and a flange loosened; but no other damage was done. The dimensions of the hole were—depth 13·5, and breadth 11 inches; the resistance of the armour being so terrific as to force the steel head of the shell back again on to the deck. Great satisfaction was expressed by all those present, and a third shot was deemed unnecessary.—*The Times.*

CHARCOAL.

CHARCOAL is made by burning wood in such a manner that but little air shall be admitted during the operation, that is, only sufficient to keep up the combustion of the more easily destroyed parts of the wood. The best result is produced, when the wood is quite excluded from the air, as in making acetic acid; but where large quantities of charcoal are used for common fuel, as in France, of course this process is too expensive. The usual way is to pile up billets of wood, and cover the whole with turf; when fired, the wood consumes gradually, and the charcoal is left behind. It is light and porous, and of a shining black colour; it weighs about one quarter as much as the wood used, and burns without flame or smoke, giving out a strong heat. When charcoal burns, it combines with part of the air, and is converted into a gas called carbonic acid, which, although invisible, is much heavier than air, and is a deadly poison; it is therefore necessary, when it is burning, always to have some opening at the bottom of the room. Many fatal accidents have arisen from people sleeping in a small room with a pot of burning charcoal, and no outlet for the poisonous vapour but the chimney, up which it will not pass on account of its weight. Charcoal enters into the composition of gunpowder, and is used for several other purposes. It is an excellent sweetener of foul water, and a few pieces should always be kept in the top of the filter when the water has any bad odour, or in the cistern, (where a filter is not used). A sort of cage, with a bottom of wire-netting, filled with charcoal, should always be fitted into the top of a cesspool, to suck in the poisonous gas that rises from it. When powdered, it has also the power of taking away the colour of many liquids, as well as the bad smell; vinegar, if warmed with powdered charcoal and then strained, will be almost colourless. Water-butts are sometimes burnt or charred inside, that the water may be better preserved in them.

Chemically considered, charcoal consists of carbon, with a certain amount of earthy matter, the ashes or earthy part of the wood from which it was made, but these ashes may be easily removed by maceration in an acid, the charcoal then remains unaltered in appearance, and consists of carbon, but its structure is exceedingly porous.

ILLUSTRATIONS OF LIGHT.

Sir Charles Bell has described some curious phenomena in optics, which will be very easily comprehended by the previous knowledge of two or three acknowledged facts.

Vision, or sight, is produced by the rays of light, (which fall from the sun or any other source of light, on an object,) being reflected from thence, so as to fall on the retina or back part of the eye; thus the moon is seen by the rays of light (which fall on it from the sun), being reflected back to the eye, and a tree, a house, or any other object is seen by the daylight (which falls on the tree or the house), being in like manner reflected on the eye.

A ray of light is compounded of many rays, and may be divided into seven, capable of causing to the eye the sensation of so many different colours; red, orange, yellow, green, blue, indigo, and violet. If all these are reflected together, they produce on the retina the sensation of white, as from this paper. If these colours, in their proper order and proportion, be painted on the broad rim of a wheel, and that wheel be swiftly turned round, it will appear of an uniform and white colour. Black is the absence of all colour, when the rays are all absorbed and none reflected. The separation of a ray of light into colours is a beautiful experiment, and easily performed. Get a prism, which may be procured at any optician's for a trifle; it is a piece of glass a few inches in length, with three sides in the form of a triangle.

Place this prism, P, opposite to a hole in the closed window shutter or screen, so that a beam of light, S, from the sun may pass through, and be received on an opposite screen, E. The image of the sun will appear on the paper of an oblong form, rounded at the extremities, and straight at the edges; this image is called the prismatic spectrum, the principal part of which will be composed of seven parallel spaces of different breadths, and exhibiting seven different colours. The lowest colour is red, and above it appears successively, orange, yellow, green, blue, indigo, and violet, which is the highest coloured space. If we suppose the coloured part of the spectrum to be divided into one hundred parts, the red space is found to occupy eleven of those parts, the orange eight, the yellow fourteen, the green seventeen, the blue seventeen, the indigo eleven, and the violet twenty-two.

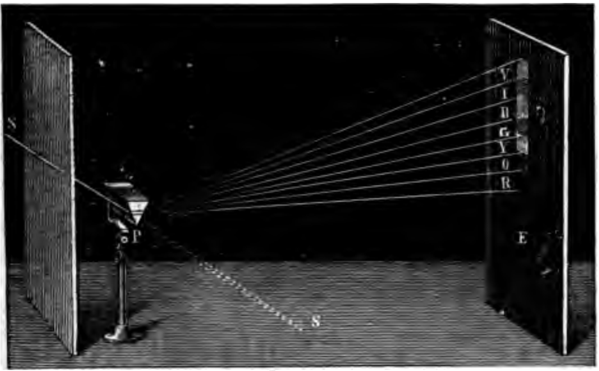


Fig. 1.

The retina is the internal coat of the eye; it consists of a delicate pulpy nervous matter, which is contained between two membranes of extreme fineness, and these membranes both support it and give to its surfaces a smoothness mathematically correct. The matter of the nerves, as well as their supporting membranes, are perfectly transparent during life. Vision is not excited by light, unless the rays penetrate through the transparent retina and reach the exterior surface from within. The retina is subject to exhaustion. When a coloured ray of light impinges continuously on the same part of the retina, the retina becomes less sensible to it, but more sensible to a ray of the opposite colour. When the eye is fixed upon a point, the lights, shades, and colours of objects continuing to strike upon the same relative parts of the retina, the nerve is exhausted; but when the eye shifts, there is a new exercise of the nerve. The part of the retina that was opposed to the lights is now opposed to the shades, and what was opposed to the different colours is now opposed to the other colours, and the variation in the exciting cause produces a renewed sensation. From this it appears how essential the incessant searching motion of the eye is to the continued exercise of the organ.

The familiar fact which we have to carry with us into this inquiry, is, that if we throw a silver coin upon a dark table, and fix the eye upon the centre of the coin, when we remove the coin there is, for a moment, a white spot in its place, which presently becomes deep black. If we put a red wafer upon a sheet of white paper, and look upon it, and continue to keep the eye fixed upon the same point, upon removing the wafer, the spot where it lay on the white paper will appear green. If we look upon a green wafer in the same manner and remove it, the spot will be red; if upon blue or indigo the paper will seem yellow. These phenomena are to be explained by considering that the nerve is exhausted by the continuance of the impression, and becomes more apt to receive sensation from an opposite colour. All the colours of the prism come into the eye together from the surface of the white paper when the wafer is removed; but if the nerve has been exhausted by the incidence of the red rays upon it, it will be insensible to these red rays when they are thus reflected together with the others from the white paper; the effect of the rays of an opposite kind will be increased, and, consequently, the spot will be no longer white, but of the prevailing green colour.

Let us see how the loss of sensibility produces an effect in engraving, where there is no colour, and only light and shade.

Is it possible that a high tower, in a cloudless sky, can be less illuminated at the top than at the bottom? Yet, if we turn to a book of engravings, where an old steeple or tower is represented standing up against the clear sky, we shall find that all the higher part is dark, and that the effect is picturesque and pleasing. Now, this is perfectly correct, for though the highest part of the tower be in the brightest illumination, it is not seen so; it never appears so to the eye. The reason is that when we look to the steeple, a great part of the retina is opposed to the light of the sky; and on shifting the eye to look at the particular parts of the steeple, the reflected light from that object falls upon the retina, where it is exhausted by the direct light from the sky. If we look to the top of the tower, and then drop the eye on some of the lower architectural ornaments, the effect infallibly is, that the upper half of the tower is dark. For example, if looking to the point A, fig. 2, we drop the eye to B, the tower from A to B is seen by that part of the retina which was opposed to the clear sky from A to C; and it is dark, not by contrast, as it would be thoughtlessly said, but by the nerve being somewhat exhausted of its sensibility.

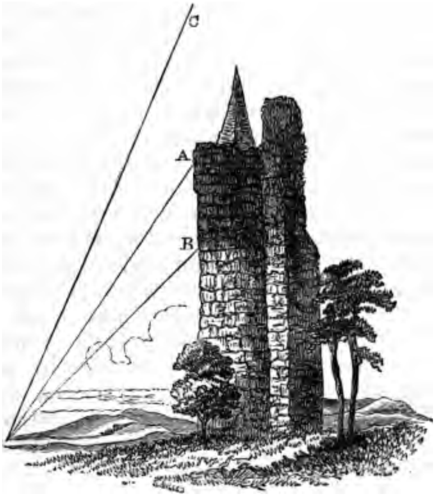


Fig. 2.

ELECTRICITY.

ELECTRICITY is the term employed to designate that important branch of experimental philosophy which relates to the properties exhibited by certain substances when rubbed against, or by some other means made to communicate with, each other. It is derived from *electron*, the Greek word for *amber*, electric phenomena having been first observed in that body, when rubbed against flannel, or on a coat sleeve.

Of the true nature of electricity we are compelled to acknowledge our ignorance. There is no doubt that it pervades all material bodies, animate as well as inanimate, but in what it consists or how it is constituted are questions too difficult for us to solve. We do not even know whether electricity is material or not. If it be, it is so subtle and refined in its nature that it passes with inconceivable velocity through the hardest substances, and if allowed to accumulate in them, it does so without making any difference either in their weight or their dimensions. On this account it is that electricity (as well as light and heat) is denominated an *imponderable* element, to distinguish it from those forms of matter which possess the qualities of length, breadth, and thickness, and consequently *weight.*

Electricity is developed in a variety of ways; but whatever be the nature of the materials, or of the process employed, we may justly conclude that the principle is in all cases identical, however different it may appear to be either in its effects or its mode of operation.

When a piece of glass is rubbed with silk, or a stick of red sealing-wax with woollen cloth, each substance acquires a property not possessed by it whilst in a quiescent state, and which consists in alternately attracting and repelling feathers, straws, dry leaves, fibres of cotton, and many other light substances. The electricity thus excited is called ordinary, and sometimes common electricity.

The following simple apparatus will illustrate quite sufficiently for our purpose electrical excitement:—

Let a clean and very light downy feather be attached to a piece of white sewing silk about three feet long, and suspended from the ceiling or other part of a room in such a manner, that it shall be eighteen inches or two feet distant from all surrounding bodies; then provide a piece of glass tube, say, three-fourths of an inch in diameter, and thirty inches long, the tube being perfectly clean and dry. If it be rubbed briskly with a warm and dry silk handkerchief, it will be electrically excited, and on advancing it slowly towards the feather, the latter will be attracted by and adhere to it; but on separating them, and again bringing the tube near the feather, that body will be as promptly repelled as it was before attracted. After a little time the feather will again approach the tube and again be repelled by it, and this alternate action will continue until the whole of the electricity excited on the surface of the tube has been dissipated; but a fresh supply may be obtained, as often as required, by rubbing the tube with the handkerchief, as already described.

One of the most important principles connected with the science of electricity is indicated by the preceding experiment, which is, that there are two kinds, or, if not two kinds, two opposite states of electricity. Thus, when the feather has received a portion of the electricity which is excited by friction on the glass, it is no longer attracted by the latter, but, on the contrary, repelled; whence it is inferred that the electricity of the feather whilst in a quiescent state, and that of the glass after being rubbed with silk, are dissimilar, and therefore it is concluded that bodies imbued with opposite kinds, or which are in opposite states of electricity, attract, and those in similar states repel each other.

The distinction to which we have just referred will be more satisfactorily shewn, if we take a large stick of red sealing-wax and excite it by rubbing it with a piece of dry and warm woollen cloth. On presenting the excited wax to the feather it will be first attracted, then repelled, as noticed, with the glass; but when the feather is repelled by the wax, if we approach it with the excited glass it will be instantly attracted, and when repelled by the glass it will be attracted by the wax. It is hence sufficiently plain that the electricity developed by glass differs from that produced by wax; and whether the difference is described as being dependent on opposite kinds, or opposite states of electricity, the effect is the same.

If we take a piece of glass tube, rub it with a silk handkerchief, and hang it to a piece of string, then rub a piece of sealing-wax with a bit of woollen cloth, and present one end of it to one end of the glass tube as it hangs, the wax will *attract* the glass towards it. On the contrary, if we rub a piece of glass and present it to one end of the suspended glass, we shall find it drive the latter away from it, or, as we say, *repel* it.

So, if we suspend a piece of sealing-wax in the same way, after rubbing it, and then put a piece of rubbed sealing-wax to one end of it (so as just not to touch it), we shall find it *repel* the other, while a piece of rubbed glass will *attract* the wax.

We might use many other substances instead of wax, such as sulphur, amber, shellac, gutta percha, resin (or what are called *resinous* substances); and, instead of glass, we might use crystal, diamonds or other precious stones of a glassy kind (or what are called *vitreous* substances), and we should find the general law,—that resinous substances when rubbed repel each other, and vitreous also repel each other, but that resinous attract vitreous bodies, and vitreous attract resinous; or, in short, that *like repels like, and opposite attracts the opposite.* This, then, is the fundamental law of electric action, *electricities of the same nature repel each other, electricities of opposite natures attract each other.*

The electricity on glass used to be called *vitreous*, and that on wax *resinous*, but now the former is called *positive* and the latter *negative;* so the feather, when charged with electricity from the glass, is said to be *positively*, and when charged from the wax, *negatively* electrified. By the terms positive and negative is implied, that in one case the substance electrified contains more, and in the other less, than its ordinary proportions.

Many common substances used by us in the common affairs of life are susceptible of electrical excitation, and we often produce electrical phenomena without being conscious of it. We may give an example or two. In cleaning glass mirrors with an old silk handkerchief, or a very dry linen duster, it generally happens that small fibres and particles of dust accumulate on their surfaces, the more rapidly in proportion to the labour bestowed in removing them. The same thing occurs in wiping decanters and other articles of glass, and especially the glass chimneys used on gas-burners. In all these cases electrical excitement is produced by friction, and the fibres disengaged from the duster, as well as the dust floating in the surrounding atmosphere, are attracted by the glass, and adhere to it, as already shewn with the glass tube and feather.

Silks of all kinds are highly electric, as are also most of the precious stones, and a great variety of resinous substances, the paste of which false gems are made, the hair and fur of animals, paper, sulphur, and some other minerals, India rubber (caoutchouc), and certain descriptions of wood, when thoroughly dried by baking.

Among domesticated animals the cat furnishes a remarkable instance of electrical excitability. When dry and warm the back of almost any full-grown cat (the darker its colour the better) can be excited by rubbing it with the hand in the direction of the hair, a process which is accompanied by a slight snapping sound, and in the dark by flashes of pale blue light.

The substances, which were just now mentioned as highly electric, must be understood as being intended merely as specimens. All subjects, without exception, are undoubtedly capable of being electrically excited; but some require more complicated arrangements than others. Those which allow the electric *fluid* (as it is called) to pass over them most easily are called *conductors*.

All metals are good conductors, and so you will see often on the top of a church steeple a *lightning conductor*, of metal wire, to attract the electric fluid, and *conduct* it down to the ground without any damage to the building. Other substances hold it fast, and do not let it pass freely. These are called *non-conductors*, or *insulators*. All resinous substances are non-conductors. This is why, if you rub a brass rod on your sleeve as you did the sealing-wax, you will not find it attract or repel the feather. No electric fluid remains on its surface, because it has rapidly been conducted along the rod to your arm, and through your body down into the ground.

THE ELECTRIC TELEGRAPH.

THE most useful practical purpose to which electricity is applied is that of sending messages by telegraph, or, as they are called, *telegrams*. You have seen those wires stretched from post to post along the sides of a railway, and you know that telegrams are sent by them, so that almost as soon as they are sent from London they are received in America. But you must not think that a letter is sent along this wire, as it is through the post, and that the same paper you give in at a telegraph office is delivered to the person to whom you sent your message; and you must not imagine that the clerk who receives it from you really sends *anything*. He reads your message, and shakes a wire in a particular way, and the clerk at the other end of the wire knows that one particular shake means, we will say, the letter A, and another means B, and so on.

Now, let us see what causes this shake or vibration, and how people can tell one shake from another. If ever you have looked about you, either in a railway station or a post office, you may have seen a thing standing on a shelf, and looking very like a small American clock, with two faces and a hand to each, and two little handles below them, or, as is now more common, only one face with its hand and one handle.

There is a kind of electricity produced by metals in contact with chemical liquid, which was discovered by an Italian, called Galvani, from whom it gets its name, *Galvanism*. I daresay some of you have been galvanized by taking hold of two brass handles fastened to two wires, and have felt the shaking vibration making all the nerves of your arms quiver. This is caused by putting a plate of zinc, B, and another of copper, *c*, in a vessel containing sulphuric acid and water. They must not touch one another in the liquid, but, if connected at the edges, which are dry, by a piece of wire, a current of electricity runs constantly through the liquid from one plate to the other, and comes back again along the wire, A. It does not at all matter what the distance is between the plates, as by lengthening the wire the current still passes through any distance, and it travels at the rate of 288,000 miles in a second of time. But as a single pair of plates would not afford a sufficiently strong current for the transmission of messages to a great distance, the former can be increased to any extent by multiplying the number of pairs of plates. For this purpose a long trough is made, in which these pairs are placed side by side (fig. 2). This is called a galvanic *battery*. A wire is attached to one end of the battery and continued to a distant station, being supported by high posts along the side of the railway, say, from London to Edinburgh, where its other end is attached to a similar battery. It has been found that, if a wire from the other end of each

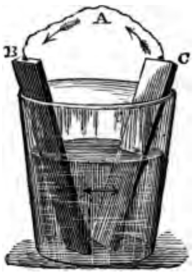


Fig. 1.

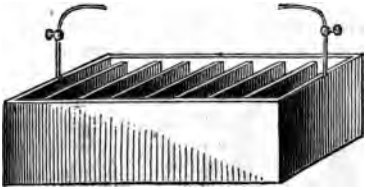


Fig. 2.

of these batteries be attached to a metallic plate sunk in the ground, the electric current is conveyed through the

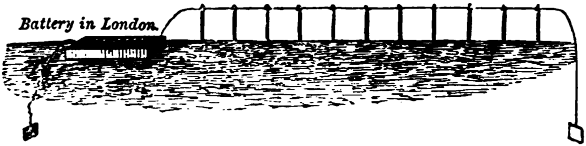


Fig. 3.

earth to any distance, so completing the circuit. Thus the electricity travels along the wire from London to Edinburgh, and returns, through the earth, from the latter to the former, as shewn in fig. 3.

You know that a magnet hung on a pivot will turn always towards the north, because of a constant natural current of electricity going round the earth from east to west. You can see this in a mariner's compass, which is a magnet needle, or by rubbing a needle with load-stone, and then floating it on a tumbler of water. About the year 1819 it was discovered that if such a needle were to be hung over a wire along which a current of electricity could be made to run, this needle would be made, by the electric current, to turn across the electric wire more or less at right angles to it, moving to the right hand or left, according to the direction in which the electricity was sent backwards or forwards along the wire. This has been applied to form electric telegraph machines. Here is a coil of wire, covered with silk so as to prevent the coils from touching. In the centre a steel needle, A, is hung on an axle which is lengthened at one end so as to hold a similar needle outside, B. The lower ends of these two needles are made rather heavier than the upper ends, so as to make them swing back again to the perpendicular position, when they have been moved by the current. As soon as the wire

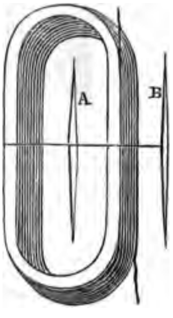


Fig. 4.

from the copper plate is connected with the end of the coil of wire to the *right* hand, and the zinc plate with the end towards my *left* hand, the current speeds like lightning along the coil from right to left, and makes the needle move towards the *left.* On reversing the communication by connecting the *right* end of the coil with the zinc and the *left* with the copper plate, the needle turns towards the *right.* It is evident that the needle, A, moving inside will also turn the outer needle, B, in the same direction, but B is only the pointer to shew how the inner one, A, is moving.

Now, if we look inside the clock-like machine, which I mentioned as being often seen in a railway station, we shall find one of these coils behind the clock-face, and the finger we see is the pointer; below we shall find a pair of wires, one descending to the battery and the other running on to the terminus at the distant point to which messages are to be sent. The outer finger or pointer, B, is that which is seen on the clock-face, and marks the direction in which the inner finger, A, turns.

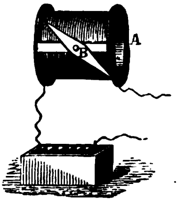


Fig. 5.

When the finger, A, in the machines we are working, is made by the current to turn towards the right, as in fig. 5, the current is continued along the whole of that wire, however far it extends, and so turns all the fingers on every machine in the line in the same direction and at the same instant. Thus, if we have a number of coils placed at different towns along the line, as London, Peterborough, York, Edinburgh, represented by 1, 2, 3, 4 (fig. 6), and the left hand wire of the coil (1) in London is attached to the copper plate, and the wire of its right

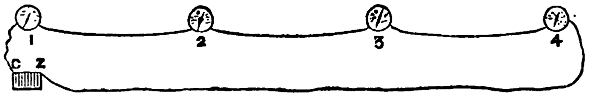


Fig. 6.

side is connected to the left side of the coil (2) at Peterborough, and its right wire to the left of (3), and its right to to the left wire of (4) at Edinburgh, and then the right wire of (4) carried back to the right side of the London battery, and connected with the zinc plate, or, as we said before, merely attached to a zinc plate sunk in the earth, the current is complete, and when it turns the needle at (1) to the right, it turns them all (2, 3, 4), as in the figure, precisely in the same direction. On reversing the current all these pointers will turn to the left. If the batteries at intermediate stations were all kept in constant connection with the wires, the needles

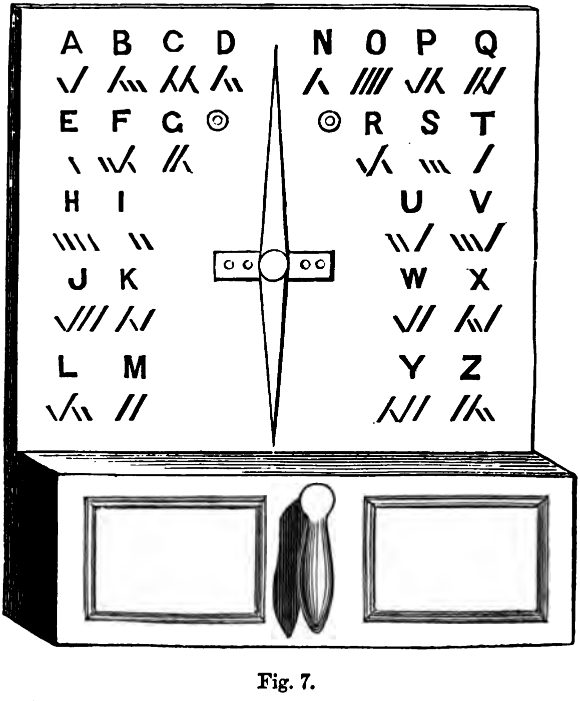


Fig. 7.

along the whole line would always point in one direction and communication be stopped. By a very simple mechanical contrivance, each battery can be connected or disconnected with the main wires when required.

But we must now close up the clock face and study it more closely. I will take the one now in general use in the Post Offices. This face has not really a clock-face dial but the letters of the alphabet are painted upon it in regular order, half on each side, as in the accompanying figure 7.

The handle is used to connect or disconnect the wire of the coil and the battery. By working it to the left the current is sent one way, and by working it to the right it is *reversed,—i.e.*, sent in the opposite direction: and the electricity running through the coil moves the needle to the right or left; when *disconnected*, the needle stands upright.

Now, look at the face of the apparatus (fig. 7.). To the left is the letter A, with one *short* line under it slanting towards the left, one *long* line slanting to the right. To telegraph the letter A, then, the needle must be moved so as to send the current once in each direction; the first movement will cause the needle to point to the left, the second to the right. So with letter B, the needle must be pointed once to the right and thrice to the left. Let us take the word "face"· we must make the needle go twice to the left, once to the right and once to the left for F; once to the left, once to the right for A; twice to the right and once to the left for C; once to the left for E. Then the clock will stop, and the needle will stand upright, because it is disconnected, and the receiver will understand that a word is finished, and if he understands it, he telegraphs one beat to the right: if he does not, he telegraphs to the left and the word is repeated. So each word in a message is spelt out, letter by letter; and, where great accuracy is required, the whole message is telegraphed back by the receiver to the sender, to make sure that he has understood it correctly. This is often desirable, as in telegraphing quickly two letters may follow one another so rapidly, that they may appear to the receiver to be only one letter; thus, C E might be received as Z: but mistakes are sometimes made by the clerk receiving the message at the instrument reading off each word, as it is transmitted, to another, who writes it down from his dictation. An instance of this occurred not long ago, where the head of a large brewing firm telegraphed to his wife—"I am *brewing* to-day, and cannot come home to-night." The clerk who wrote this message down from the receiver misunderstood the word *brewing*, and wrote—"I am *ruined* to-day, and cannot come home to-night." On receipt of this intelligence the distracted wife hired a post-chaise and posted off some thirty miles to the brewery, where, on arriving in the middle of the night, she found her unconscious husband in his shirt-sleeves presiding over the mashtub.

As messages to a foreign country are more liable to mistakes, from the clerks misunderstanding the language, a printing apparatus is attached to the instruments, which, according to the working of the needle, stamps each letter on a strip of paper at both instruments, and this is cut into words and pasted upon a message form and delivered to the person to whom it is addressed.

In calling attention to any office to which the clerk wants to send a message, he telegraphs two letters marked on what is called a code of *signals*, pasted up by the side of the instrument, which *signals* represent the office he is *calling*. These letters are generally either the first and last letters of the name of the town, or the first and most peculiar letter in the name: thus, O X stands for Oxford. He keeps on telegraphing O X, until the clerk at Oxford moves his needle one stroke to shew he is attending, when the sender of a message telegraphs the signal of the office at which he is stationed, and then begins his message.

It will be noticed, that on the dial all the long strokes denote movements of the needle to the *right*, and all short ones movements to the left. They are thus written in the book of instructions:—

A	- —
B	— - - -
C	— - — -
D	— - -
E	-
F	- - — -
G	— — -
H	- - - -
I	- -
J	- — — —
K	— - —
L	- — - -
M	— —
N	— -
O	— — — —
P	- — — -
Q	— — - - -
R	- —
S	- - -
T	—
U	- - —
V	- - - —
W	- — —
X	— - - —
Y	— - — —
Z	— — - -

A telegraph clerk has lately discovered, that by twisting the coils of wires that unite the needle to the battery, it is possible to transmit two messages with the same instrument in the two opposite directions of the same wire, *e.g.*, both to London and Edinburgh.—*Rev. J. Ridgway.*

THE BODY AND ITS PARTS.

THE bones of the human body (including the teeth) are 255 in number, and are so united as to combine the greatest strength with the most perfect freedom of motion. How is it that these parts are held together in constant action, for 60 or 70 years without wearing out? The body is capable of existing and moving for even 100 years, during which its parts are constantly worn out and restored, so that about every seven years all the old materials are entirely gone and new ones put in their place. How is this waste supplied, and the worn-out substance restored? How is it that action, which destroys most things, only strengthens the human body? You know that any machine, if it is always running, wears out, and wants a new wheel here and a new rivet or spindle there, and we say "it is worn away;" but the more you work your arm or your leg, the bigger and stronger the muscles of the arm or leg become.

Before we answer these questions, it is necessary to know a little about the structure of the body, which consists of three great parts, viz.: the head, trunk, and limbs.

1. The head surmounts the fabric, and is a sort of ball, formed mainly of plates of bone, so arranged and fitted together as to unite the greatest possible strength with the greatest possible lightness. The interior of the *skull* (which consists of eight bones) is entirely filled with brain, which is the root of all sensation and life. It is the centre in which all the senses meet, through which the brain gets all its ideas.

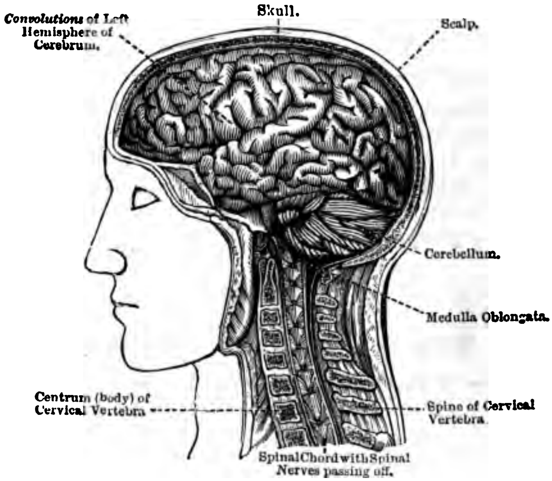

Convolutions of Left Hemisphere of Cerebrum.
Skull.
Scalp.
Cerebellum.
Medulla Oblongata.
Centrum (body) of Cervical Vertebra
Spine of Cervical Vertebra.
Spinal Chord with Spinal Nerves passing off.

Fig. 1.

There are five of these senses, viz.: touch, taste, smell, sight, and hearing, of which we shall speak more particularly presently. Each has its own nerve, or set of nerves, running from the brain to the organ of sense. Thus, there is one for smell running to the nose, one for sight to the eyes, one for hearing to the ears, while those for touch are more numerous, because the sense of touch belongs to the whole surface of the body.

The *face* is composed of fourteen bones, which are in pairs—(except the partition between the two nostrils and the lower jaw-bone) one to each side of the face; thus, there are two cheek-bones, two to form the upper jaw, two to the palate, two lower spongy bones, two protecting the eyes, and two forming the nose.

Besides these main bones in the face, there are thirty-three of a peculiar construction, called *teeth*, formed of a softish bone-like matter, covered with a polished enamel. They are thick in the part that is visible, and taper to one or more spiked roots or fangs, which fit into sockets in the jaw. Circulation takes place through a hole in these roots to the soft inner body of the tooth, and it is this part of the tooth which causes tooth-ache. Of these thirty-two teeth there are three distinct kinds, differing in shape according to the purpose for which they are used, and they are arranged in pairs. The two front are Incisors, or *cutting* teeth (with edges like chisels), for biting off a

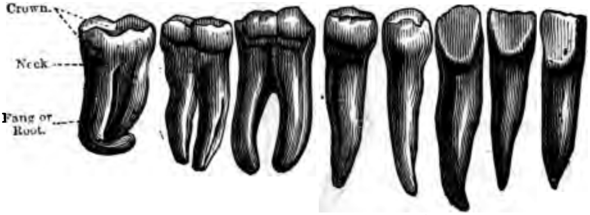


Fig. 2.

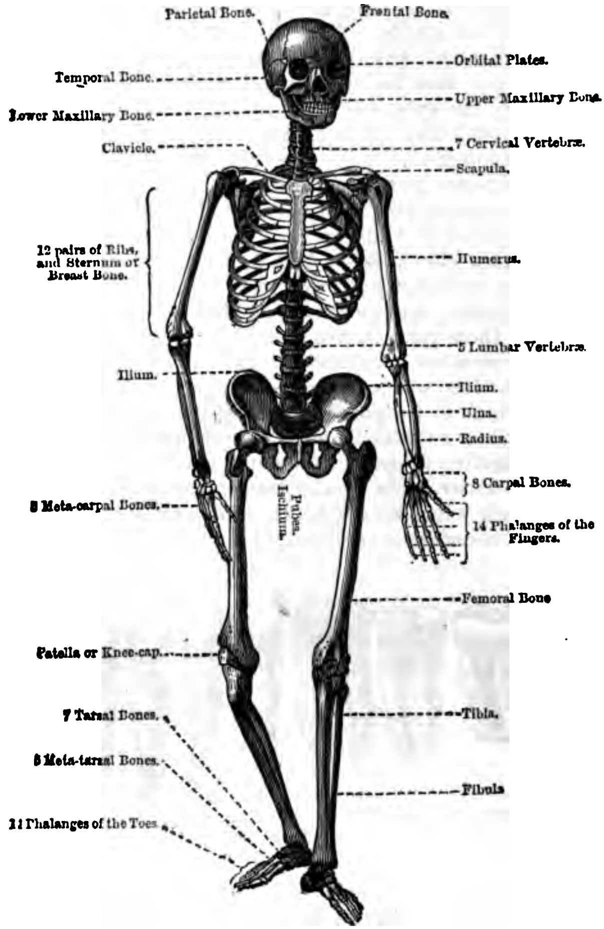

Parietal Bone.
Frontal Bone.
Orbital Plates.
Temporal Bone.
Upper Maxillary Bone.
Lower Maxillary Bone.
Clavicle.
7 Cervical Vertebræ.
Scapula.
12 pairs of Ribs, and Sternum or Breast Bone.
Humerus.
5 Lumbar Vertebræ.
Ilium.
Ilium.
Ulna.
Radius.
8 Carpal Bones.
5 Meta-carpal Bones.
Pubes.
Ischium.
14 Phalanges of the Fingers.
Femoral Bone
Patella or Knee-cap.
7 Tarsal Bones.
Tibia.
5 Meta-tarsal Bones.
Fibula
14 Phalanges of the Toes

Fig. 3.

portion of food from the main piece, as a mouthful from a slice of bread and butter; there are a pair, *canine*, or dog-teeth (one on each side), with a more pointed edge, for tearing anything; they are sharper than the cutting teeth: then follows another pair, *bicuspids*, resembling the former in having only a single root, but having double edges like the six *molars*, or grinders which masticate the food.

2. The *trunk* is the broad part between the head and legs, commonly called the *body*. It is made up of a great number of bones. The principal is the spinal column: a chain of little bones strung, as it were, together, like a string of beads, by a cord (called the spinal marrow) running up their centre. This gives the body its very easy movement, so that it can bend in every direction. You may have seen a toy in the shape of a snake, made of little bones, like buttons, strung together, and if you take hold of its tail, it will bend about and move its head as if it were alive. That is a very good illustration of the back-bone.

On the top of the spine, the head rests on a sort of double pivot; branching off on each side are the hoop-like ribs, that make, as it were, the barrel of the body and protect the lungs and heart; behind them are the shoulder-blades, and above, in front, the two thin *collar*-bones; below are the broad bones that protect the intestines, and to which the legs are hung. They form a sort of basin in the lower part of the trunk, and the chief bone is called a basin, or *pelvis*, which is its Latin name. You can feel the top edge of it just below the waist.

3. The *limbs* of a man, and of all four-legged animals, are the same in number and in their general plan; nor is there much difference in the number of bones composing each. In the latter we call them all *legs*, because they are all used for walking upon the ground, and none of them for grasping any object; but though the ox, horse, sheep, pig, &c., make no such use of their fore-legs as we do, yet we see a gradual approach amongst quadrupeds to such a use; for instance, the dog *paws* his master, holds

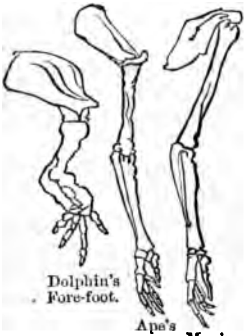


Fig. 4.

his food; the monkey grasps the branch of a tree, and holds nuts to his mouth with his fore-paw. But though all these bear a strong family likeness, they differ in the upper limbs (fore-legs or arms), the horse having no fingers or toes, the cow, sheep, pig, &c., only two on each foot; while of those which make use of their fore-limbs for any purpose approaching to our use of the hand (as the monkey), there is a marked distinction in the position of the thumb, which in man is so placed as to give the greatest power in grasping; and any one can see for himself how clumsy even a clever monkey is in handling a nut or a stick, compared with the delicacy with which a man can pick up a pin, or fit in the most delicate parts of a machine (such as a watch), or lightly paint a picture. A similar, but more marked distinction, is shewn in the position of the great toe, projecting backwards rather than forwards in other animals than man.

The arm and leg of a man almost exactly correspond in the number of bones, as well as in their arrangement. This will be clear from the following table:—

Upper Limb.		Lower Limb.	
Arm, ...	1 bone.	Thigh, ...	1 bone.
Fore-arm, ...	2 bones.	Leg, ...	2 bones.
Hand.		Foot.	
1st *Carpal* row, . .	4 bones.	1st *Tarsal* row, . .	3 bones.
2nd ,, ,, . .	4 ,,	2nd ,, ,, . .	4 ,,
Metacarpal ,, . .	5 ,,	*Metatarsal*, ,, . .	5 ,,
1st Phalangeal row, .	5 ,,	1st Phalangeal row, .	5 ,,
2nd ,, ,, .	5 ,,	2nd ,, ,, .	5 ,,
3rd ,, ,, .	4 ,,	3rd ,, ,, .	4 ,,

Starting from the shoulder of the arm and the hip of the leg, the first length consists of a single bone, working in a ball and socket joint, and the second, of two, capable of turning one over the other, so as to twist and roll the hand or foot. Between this length and the flat termination (called *hand* and *foot*) there is a set of small bones (composing the *wrist* and *ankle*), so as to admit of free motion in the hand and foot; then follow those which are seated in the broad part of the limb, and to which the fingers and toes are attached by joints working like hinges.

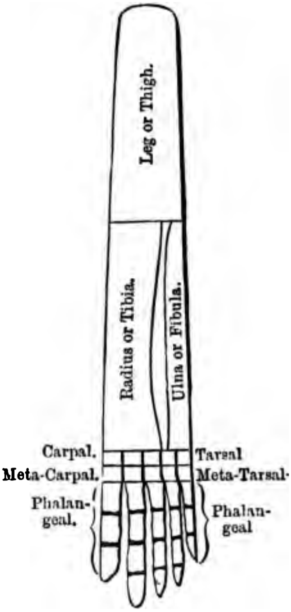


Fig. 5.—Form of Hand and Leg.

The *joints.* These bones would be of very little use to us, except for keeping the body erect, if it were not for the joints, which are like hinges fitting the various bones together, and enabling them to move one upon another. If it were not for these joints man would be no more able to walk than a lamp-post.

There are three principal kinds of joints, viz.: the ball and socket (of which that between the shoulder and upper arm form an example), the hinge, F (fig. 6), as that at the elbow and knee, and the pivot, F (fig. 7), as that at the wrist and ankle. The bones at these joints do not stick together, but are held in their places by certain tough strings fastened to the end of the muscles above and below the joint, so that the contraction or expansion of either muscle moves the bone and bends

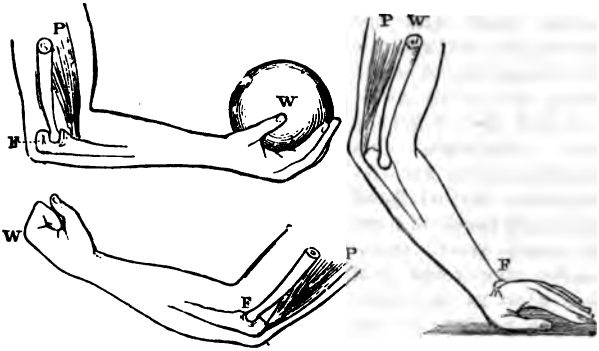


Fig. 6.

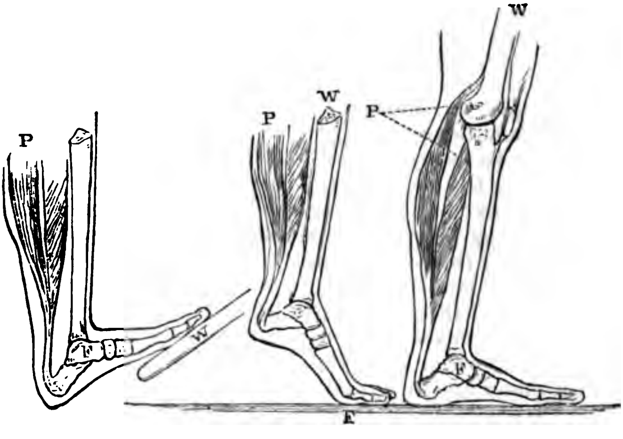


Fig. 7.

the joint, just as your taking hold of the lid of a box and raising it works the hinges; or pushing the weight at the bottom of a clock pendulum makes it swing on the pivot where it is hung. This will be seen by the accompanying diagrams. The contraction of the muscle, P, shortens and tightens it, which makes the joint, F, bend, drawing the hand up towards the face. At the same time, if we throw the body forward a little, the tightening of P (fig. 7), pulls the string (or *tendon*), and raises the heel, so that a step forward is made in walking. Then the contraction of the muscle of the thigh pulls its tendon, and straightens the *femoral* bone, drawing it into a straight line with the leg below the knee, thus pulling the body into an erect position. But as these joints would soon wear out by rubbing against one another, they are kept well supplied with a kind of oil that makes them work smoothly.

Muscles are what we generally call *flesh*, being red from the blood-vessels in them. We could not do without muscles, as they cause all movement by contracting and expanding, so as to turn the bones on their joints, work the lungs in respiration, and keep up the pumping of the heart, the thinking of the brain, and the movement of the food in mastication, swallowing, and digestion; so that we can neither work nor play, stand, kneel, nor sit without them; and, as they are equally required for circulation, respiration, and absorption, we cannot even live, when asleep, without their aid.

ON DIGESTION.

You know that your bodies wear out by use, just as your shoes do by walking on them. But every now and then your shoes have to go to the cobbler, and a new sole is put on in place of the one that was worn off. Now, when we run, or walk, or play cricket, or think, or talk, or breathe, or eat, we wear off some part of our bodies; but we do not every now and then send the body to a workman to have a new piece put on here and a patch there, where the old parts have been worn away; but we keep mending every bit of the body as fast as it wears off, and putting in fresh material as good as the old.

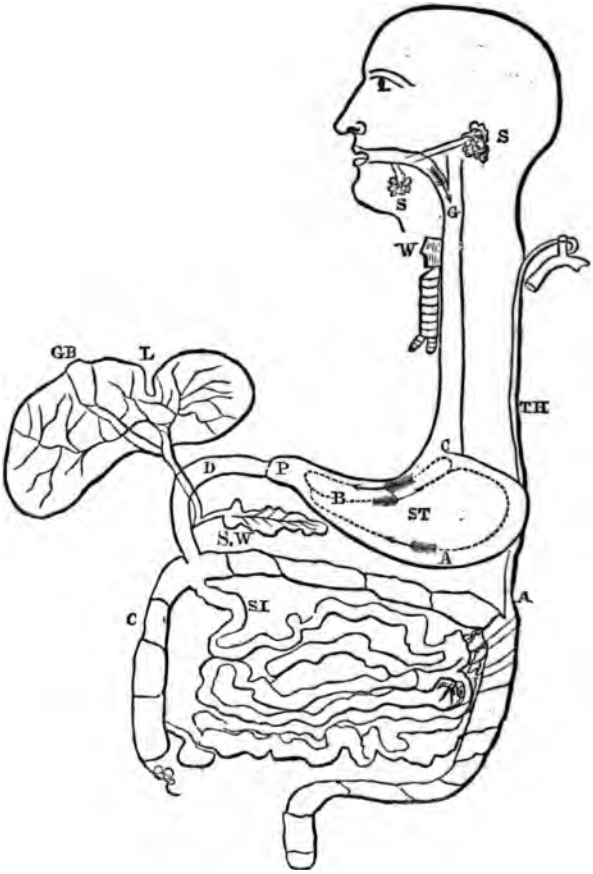
The cobbler takes a piece of leather, and nails it or stitches it on to the shoe; but we cannot take a piece of meat and stitch it on to our arms to thicken them, if they have got thin, but we do get it on to our arms in another way. You may have seen people put wool or cotton into a machine at one end, and then have seen it come out in threads of worsted or cotton at the other; or you may have watched people in a paper-mill put a quantity of old rags into a large vat, and then seen it come out in large sheets of paper at the end of the machine. Your body is a machine which manufactures what you eat into flesh and blood and bone, just like the paper-machine turning rags into paper; only it manufactures everything it wants for its own use, it does not turn it out for sale. It uses up all it wants to mend itself with, and only turns out what it does not want. Let us see how it does this.

When your body has worn away some parts by your working or playing for a few hours, you feel tired and hungry. You come in and get your dinner, and by the time you have finished, you do not feel tired, but you are ready to run off and play again. When you felt hungry, your machine wanted something put into it, and you were tired, because it was worn and almost standing still for want of something to work upon. So you put in more stuff, and it went to work again, and mended what was worn, and then you could run about as fresh as ever.

What did you put into the machine? A piece of bread and butter, which you bit off a slice with your two front teeth (the cutting teeth). This was very quickly rolled by your tongue into the middle of your mouth, and you felt your mouth water, and the dry bread began to get moist. Your tongue and your cheeks kept working it backwards and forwards between your back teeth, till it was ground quite small, so those teeth are called grinders. Now, let us see what has happened to it? I daresay some of you have chewed some wheat in that way, and then have taken it out of your mouth and found it a sticky paste, and made bird-lime of it. You will find, too, that after you have begun to chew it, it tastes sweet. This sweet taste is because it is changed by the moisture of the mouth (which is called *saliva*), into sugar, and it is sticky, because some part of it is also changed into *gluten*. So we have these two changes of bread in the mouth into sugar and gluten, and this is the first part of digestion. This paste is now fit to make fat in your body, and keep you warm. The butter mixed with it is also fat. If you eat any potatoes, just the same thing happens to them as to the bread.

But now you put a piece of meat into your mouth, and chew it in the same way till it is quite small and mixed with saliva, but it is not changed, like the bread, into sugar. You swallow them both by the action of the tongue, which rolls the food up into a little ball, and pushes it to the back of the throat, where it drops into the gullet. This gullet is a pipe fitted with rings, and as the food touches each ring, the ring closes and squeezes it on to the next, and so it is pushed gently down into the stomach. You may see these rings working in a horse's throat, if you watch it drink. A little gristly curtain at the back of the mouth (called the *palate*) prevents any food from going up the nose, the entrance to which is closed by it in the act of swallowing. The same act also pinches together the sides of the windpipe, and covers them with another piece of gristle, called the *epiglŏttis.*

The stomach, into which the food falls, is a bag of muscle, something like a bladder, with a small pipe at each end. Its inside is lined with a velvety sort of covering, like the rougher side of tripe and the rough part of



S. Salivary Plants.
G. Gullet.
W. Windpipe.
St. Stomach
P. Pylorus.

D. Duodenum.
L. Liver.
G.B. Gall Bladder.
Sw. Sweetbread.

C. Colon or Large Intestine.
S.I. Smaller Intestines.
A. Absorbents.
Th. Thoracic Duct.

Fig. 8.

our tongues. This roughness is caused by little tubes with their pointed ends outwards. As soon as they are touched by food coming against them, they begin to sweat out a liquid, called *gastric juice*, which moistens the food, and changes its nature, separating the fluid from the solid part, and dissolving the latter (except fat).

The food enters the stomach at the upper right-hand corner (*c* of the diagram), and the muscles contracting at that point, push it towards the left along tho upper surface (*a a*) till it gets to P, which is closed by strong muscles. It then returns down the middle, *b*, and on reaching the end to the right hand, divides into two streams, one going along the top, *a a*, the other along the bottom, *d*. This constant circulation, which is kept up by the two sets of muscles in the stomach (one working lengthwise and the other circular-wise) both grinds all the hard parts of food against the rough surface, so reducing it to a powder, and also thoroughly moistens it all with gastric juice, until it is brought to a thin milky pulp, called *chyme*. As each portion of chyme in a sufficiently liquid state comes to P, the pipe (called *Pylorus*) opens a little and lets it out, the rest continuing to circulate, until all that can be dissolved is thus passed out. During this process, the stomach contracts at each flow of liquid out of the pylorus, so that the remainder is always being rubbed by the coat of the stomach. When all has been passed out that can be dissolved, the pylorus opens wide and lets out the sediment, and the stomach remains at rest till the next meal.

This chyme now passes through a curved pipe, called the *Duodenum* D, where the *bile* from the gall-bladder (G B), of the liver (L), and the *pancreatic* juice from the sweet-bread (S w) are mixed with it. This mixture completes the digestion of the fat and sugar, which have not undergone any change in the stomach, and it is now called *chyle*, in which state it is ready to be poured into the veins to form new blood, and give nourishment to the body.

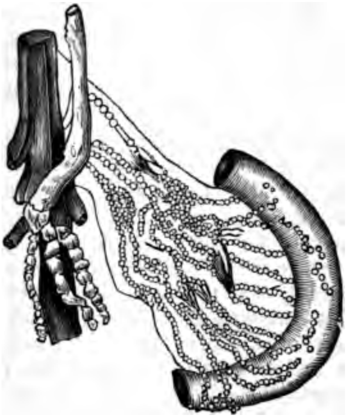


Fig. 9.

A set of very small pipes, like hairs (called *capillaries*) touch the smaller intestines, into which the chyle runs next, and suck out through the walls of the intestines what is nourishing, and convey it into one larger pipe (the thoracic duct, Th, fig. 9) which carries it up by the spine to the left side of the neck, where it flows into a large vein (*vena cava superior*), mingling with the return blood from the head, and is carried to the heart, which pours it into the lungs for purification, when it is fit for restoring the waste of the body. The refuse or fibrous part of the food, which does not contain any nourishment, or is incapable of being digested, now passes from the smaller into the larger intestine, through a little mouth or valve. This large pipe is called the *colon,* and first *ascends* the body for a short distance (and is called the *ascending* colon); then crosses over the body (and is called the *transverse* colon), next goes downwards (getting its name of *descending* colon), when its form changes into a *straight* pipe (the *rectum*), by which the refuse matter is conveyed away from the body; so this part of the intestines may be called the main sewer.

The relative positions of the gullet A; stomach, B; liver, C (with its gall bladder, D); the duodenum, E; sweet-bread, F; smaller intestines, G; larger intestines, or colon, H; and rectum, I, will be best seen by reference to the accompanying figure.

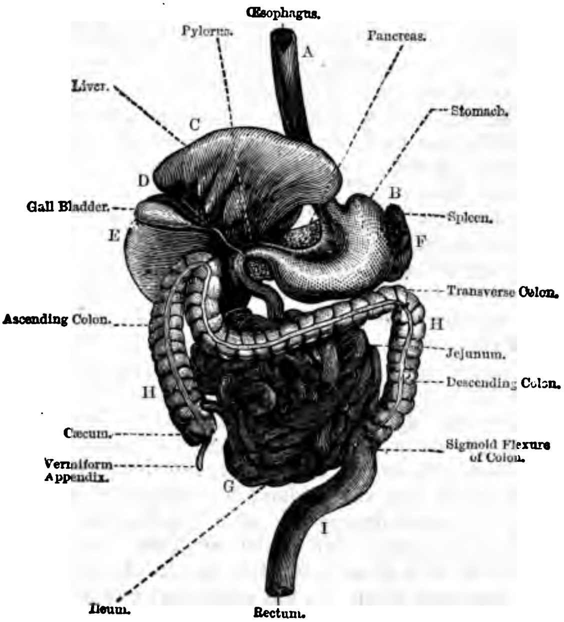


Fig. 10.

SOLIDIFICATION.

We have now got the food we eat distributed all over the body in a liquid state, and there it lies ready to be made into flesh and blood; but it is soft and liquid, like milk, only coloured red by the oxygen of the air. How, then, does it become solid flesh and bone? This is the last process. I dare say you know that a farmer's wife takes her milk and cream, warms it a little, then puts it into a small shallow tub, sprinkles a little salt, some colouring matter, and other things of that kind upon it, and then leaves it quite still *to set,* as she says, and in a few days it has got solid, and in time becomes a cheese, almost as hard as a piece of wood. Now, it is something like this with our food. This milk gets its colouring matter from the air, and a little salt and mineral matter is eaten with our food, and then it requires to be left quite still *to set,* until it becomes solid flesh and hard bone, like a piece of wood. This is why, when you have run about in the fresh air, and filled your blood with oxygen, you feel so sleepy. The milky food is ready for *setting,* and it wants to be left quiet and still *to set.* So you go to bed and are soon fast asleep. But what happens during sleep? Why, this new blood is set and made solid. The blood scarcely circulates at all during sleep; it is almost still, just moving a very little to keep up the current, and prevent the veins closing up or getting clogged with waste matter. The mind is at rest, the body does not move, the senses are all closed (you neither see, nor smell, nor hear, nor taste, nor feel, when you are asleep), the tongue is quiet; so, as there is no action, there is no work for the blood to do; but it is lying still to be set into solid matter. Sleep, then, is necessary for the repair of the body, as well as food and fresh air, for without it our food would remain liquid blood, and we should not restore the flesh and bone worn away by exercise. We take in our material by day, but we manufacture it into the various articles we want for repair of the body, and put the new material into its proper place, only during the sleep of night.

CIRCULATION.

We have seen how food is turned into blood; but it is not like blood at first, for it is white like milk, not red like blood. We have next to see how it gets its red colour. When it has been poured into the vein on the left side of the neck, it runs into the heart, which acts like a force-pump, and sends it up a pipe into the lungs.

The lungs are very-like two large sponges, one on each side of the heart, and a little above it. The heart forces the blood up the pipe (called the *pulmonary* artery), which then branches off into smaller pipes, and these divide into a great many very little ones, as fine as hairs, like the branches of a tree, and carry the blood into all parts of the lungs, just like those parts that form the substance of the sponge round the little holes. You can understand this if you dip a sponge into ink, and you will then see what part of the sponge is black, and that there are little holes where there is no black. The blood is not quite black, but it is blue. Look at the veins on the back of your hand and you will see the colour.

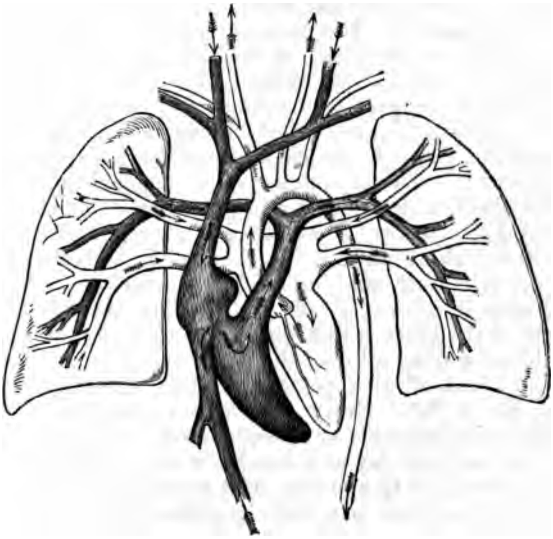


Fig. 11.

Now, draw in a breath, and the air rushes down your windpipe, and is carried by two pipes, by one to the right and by the other to the left lung. These two pipes branch out into very small hair-like tubes, and carry the air into the little holes or cells in the sponge of the lungs. So there are an immense number of cells filled with air, and surrounded by tubes of blood, only separated from this air by the finest possible skin. The air contains a great deal of *oxygen* gas, and the blood a great deal of *carbonic* gas (which gives it that dark colour). These two gases cannot come so close together without rushing towards one another; so the carbonic gas rushes through the skin of its tube to get to the oxygen, and the oxygen rushes through the skin to get to the carbonic gas, and in their haste they rush past one another. The carbonic gas fills the air-cells, and the oxygen is caught by the blood, gets mixed with it, and is retained in the veins. This has all happened in a very little part of a second, and we breathe out again, sending the carbon out of our mouths into the air outside, and it is got rid of from the body, because it poisons it. The oxygen has quite changed the colour of the blood, which is now a bright red; but it has also changed its nature. It was dead matter (for we do not eat live flesh), dead and flat, like milk; it is now life-giving, sparkling, and brisk, like ginger-beer, and in that state it returns to the heart. But we must now see what the heart is like, for it is the pump that keeps the blood moving all over the body.

The heart of each person is about the size of his own closed fist. Every one knows the shape of a heart, and a bullock's or sheep's heart, lungs, and liver may be seen any day at a butcher's shop. But now let us see what it is like inside. Cut an orange in half, and you will see there is a white partition running across the middle, which divides each half into two portions, separating one from the other. The heart is very like that; there is a partition between the upper and lower half, only there are holes in each partition fitted with valves, so as to let the blood fall from the upper half to the lower, but which close, so that it cannot return from the lower to the upper one. Paste a piece of thick drawing paper over each half of the orange, and then fit the two halves together and you will have a very good idea of a heart. These two thicknesses of drawing paper will make a wall between the two halves of the heart, so that nothing can pass from one half to the other. Blood can run from 1 to 2, and from 3 to 4, but none can go from either 1 or 2 into either 3 or 4; though if we were to get a curved pipe and put one end into 2, and the other end into 3, as is done with the pipe 5, we should then be able to get a flow of blood from 2 to 3. This is very nearly what is done in the case of the heart. A pipe, like 5, carries the blood out of 2 up into the lungs, into which it empties the blood, as we have seen, by a very great number of very little pipes, and then a great many others suck the blood up again, pour it into one large pipe, which conveys it into 3. Now let us put the two halves together again, turning the cut edge outwards, and we have a very good representation of the heart in its position. Insert a quill through the rind into 1, and we have the great vein that brings the blood from the body into the heart. As soon as it has filled the cavity of 1, that cavity (which is called the right *auricle*, because it is covered with a piece of flesh, like one of your ears), begins to squeeze itself together, just as you do your hand when you double your fist. Put a sponge full of water into your hand and squeeze it. What happens? Why all the water runs out between your fingers. It is just so with the heart, when it squeezes the blood inside it, the blood is forced out through little holes in the wall between it and 2, pushing the valves open, until it has all run into 2, and filled it. Then 1 begins to open itself again, ready to receive some more blood, and 2 begins to squeeze itself, forcing the blood up a pipe (called the *pulmonary* or *lung artery*) out of one side of 2, like the *pipe* 5, (Fig. 12) into the lungs, from which

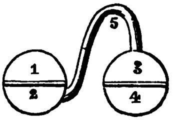


Fig. 12.

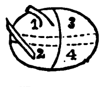


Fig. 13.

it is carried by the *pulmonary vein* to the other side of the heart, 3. As soon as 3 is full, it squeezes the blood into 4, just as 1 squeezed it into 2, and 4 squeezes it into another pipe from the bottom of it. This pipe is called the *aörta*, and carries the blood up towards the head for a little way, and then turns round, dividing itself into several branches, one going to each arm, one to each side of the head, and the main pipe going to the lower parts of the body.

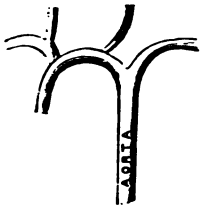


Fig. 14.

Let us now follow the course of the blood. Starting from the *right auricle*, No. 1, which we will suppose to be empty, blood is poured into it from the great veins, (lower *vena cava* and upper *vena cava*), the former of which brings back the worn out blue blood filled with carbonic acid, and the latter a mixture of waste blood, and the new chyle from the *thoracic duct*.

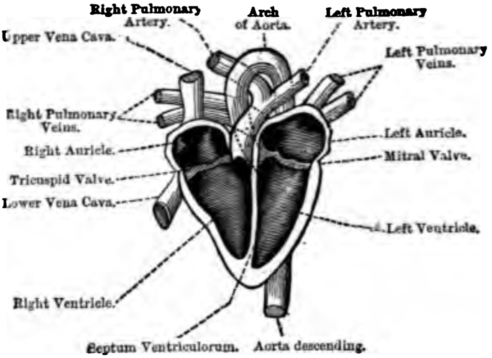


Fig. 15.—Theoretical Section of the Human Heart, seen from the front.

As soon as the *right auricle* is full, it begins to squeeze itself, or *contract*, forcing the blood down into the *right ventricle* (so called, because it is shaped something like a man's stomach or belly). When this ventricle is filled, it contracts and forces up the blood into the right and left *pulmonary arteries*, and so into the lungs, where it is distributed by small *capillaries*, is purified by the air, and being sucked up again by similar capillaries, poured by the right and left *pulmonary veins* into the *left auricle*, which contracts in the same way as the *right auricle* did, forces the blood down into the left ventricle, which in its turn forces it up into the *aörta*.

But why does not the blood at each contraction of an auricle or ventricle run back through the opening by

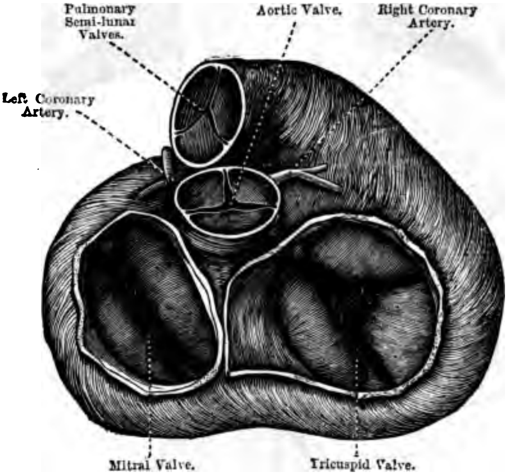
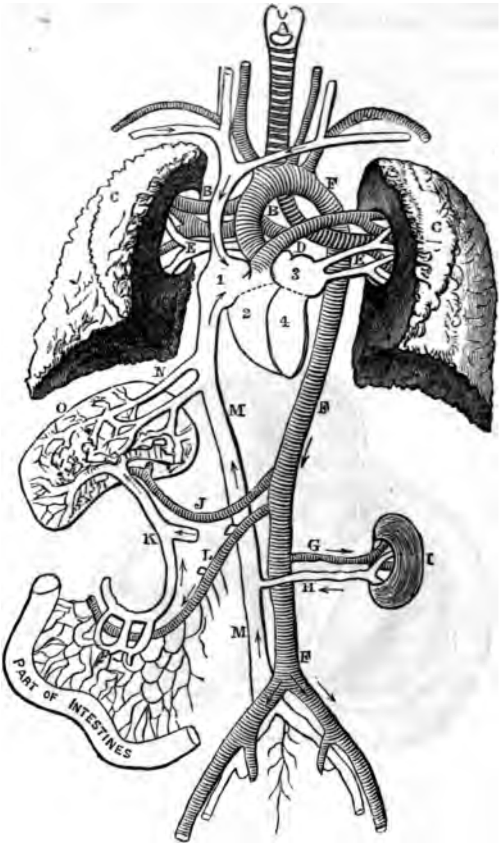


Fig. 16. The Top of Heart, the Auricles being dissected off.

which it entered? Because each of those little holes only opens forwards in the direction the blood is to take, like the valve of a pump. Suppose a reservoir were to burst and send all its water in a great bulk against the front door of a house which was left a little open, it would pour with a great flood into the house, dashing the door open against the passage wall. But



RESPIRATION.

A. Windpipe.
B. Bronchial tubes.
C. Lungs.

CIRCULATION.

D. Pulmonary arteries.
E. Pulmonary veins.
F. Aorta.
G. Renic artery.
H. Renic Vein.
I. Kidney.
J. Artery to liver.
K. Portal vein.
L. Hepatic artery.
M. Vena Cava.
N. Vein of liver.
O. Liver.

Fig. 17.

suppose it dashed against the window of the room instead, forcing it in, it would fill the room, and if the door were a little open, it would get behind it and shut it up close. It is just so with the blood in the heart, it rushes in at the open door (which opens inwards), and when each ventricle or auricle contracts, that only forces the blood against the inside of the door (opening inwards) and shuts it up close; but when it presses against those that open outwards, they fly wide open, and out goes the blood. So there are doors (or *valves*, as we call them) between each auricle and ventricle, and at the entrance into the aorta and pulmonary artery.

Now let us follow the blood along the aörta downwards. It is forced along by constant pumping of fresh blood into it by the heart and descends till it gets about the middle of the body, when one branch goes off to nourish the liver; a little lower another branch goes to replenish the stomach and intestines, and the blood for the latter (after being distributed over them), is sucked up again and carried to the liver. The main trunk, however, of the aorta still goes down, carrying blood to the legs and on to the tips of the toes. It is thus distributed by very small pipes over every particle of the body, leaving fresh matter there, and taking back instead the worn out black matter (the ashes of the system). This waste, or dirty blood, is collected by little pipes, and carried into veins which convey it up to

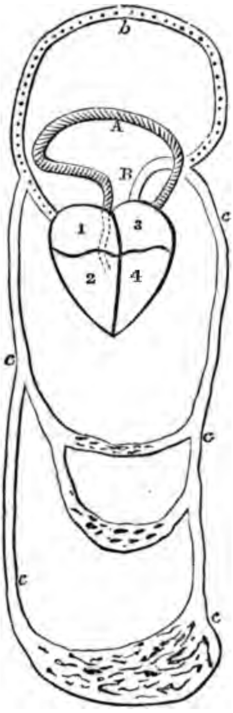


Fig. 18.

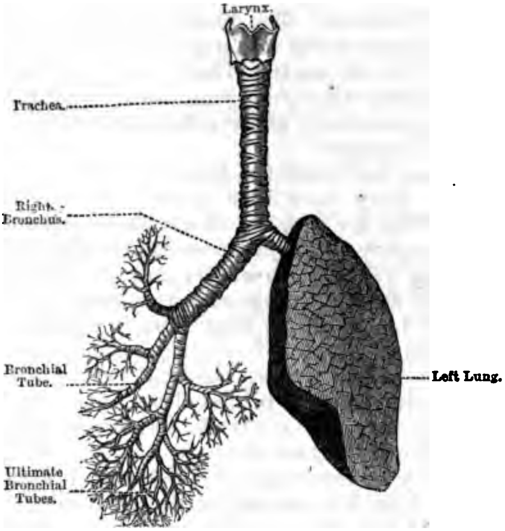
the right auricle and pour it into the heart, to be sent again to the lungs to be purified. We have thus got it back to the right auricle from which it started. It has gone its round or *circuit*, and hence this constant flow round the body is called *circulation*. But there are two circulations: *first*, A, that from one side of the heart, through the lungs to the other side of the heart; and *second*, B, that from the left side of the heart round the body to the right side of the heart, and this is divided into two, viz., *b*, that which circulates to the parts of the body above the heart; and, *c*, that which circulates to the parts below it.

RESPIRATION.

We have seen that our food, when made into blood in our bodies, requires to be changed from dead into living matter, and that blood which has circulated once through the body wants purifying by the black waste matter in it being discharged. Some of you may know that when gas is manufactured at the gas-works, it has to be purified by being passed through lime, which discharges a black matter out of it, which is called gas-tar. Now, something like that is done with our blood; and a black matter is discharged from it, called *carbon* (or *charcoal*) which is poison to the blood, and is dead matter. It is like the dirt on our hands, and in our clothes, which we wash off and get rid of; and it has a bad smell, as you may find out for yourselves, if you will go out of doors as soon as you are dressed in a morning, and then go back into the close bed-room where you slept. You will find just the same bad smell, (only rather worse) if you stand over an open cess-pool. You can prove this for yourselves if you take a glass of lime-water (which is as clear as spring-water) and blow into it for a few minutes through a quill, when the clear water will become thick like milk, the carbon having precipitated the lime. Whenever we breathe out (which is called *expiration*) we discharge this foul matter from our blood; and whenever we breathe in (which is termed *inspiration*) we take in a fresh supply of life-giving gas, which quickens the blood, and gives activity and force, as well as new substances, to the various organs of the body.

The heart is a pump constantly forcing the blood into the lungs, and then, on its return, sending it on again round the whole body, working as regularly as the pendulum of a clock. The lungs form another set of machinery as constantly and regularly drawing in air and sending it out again. Place your hand on your heart, and listen quietly to your own breathing, and you will see how exactly and regularly each of these two machines act together.

Let us now see what the lungs are like, and how they work. They have been already compared to a sponge; but they are of rather closer material, and more fleshy than a sponge. They are sometimes called "lights" (because they will float in water) and may be seen at any butcher's shop, hanging, with the heart and liver, from a long tough pipe. That pipe is the windpipe, the upper end of which is fastened just under the root of the tongue, and goes down the front part of the neck (the gullet being the pipe behind that), so there are two openings into it from the outside air, one through the mouth, and the other through the nose; the former opening is properly for the voice, and the latter for breathing (or *respiration*, as it is properly called). A little below the chin is a hard substance in the windpipe (commonly called "Adam's Apple") which is a musical instrument, like the mouth-piece of a clarionet or flageolet, fitted with two strings which vibrate (like the strings of a piano or Jew's harp) when the breath is forced through them. These strings cause the sound which we call voice. Below this the windpipe branches off into two, one going to the right and the other to the left. These two tubes, like the windpipe, are fitted with a succession of gristly rings to keep them always open; they again branch off into others, shaped almost like young trees, two on the left side and three on the right. These are called *lobes*, and they divide into a great number of branches, till they terminate in very fine hair-like tubes, which end in little bags like currants on the ends of their stalks. These little bags or *lobules* are the air sacs, and when we draw in breath, these air sacs are filled with the air we draw in. Around them are the fine tubes of the pulmonary arteries and veins spread over them like very fine net-work. So when the sacs are full of air, and the blood-vessels full of blood, the two are only separated by the very finest possible skin, finer than gauze; and, as has been said before, the oxygen gas in the air, and the carbonic acid gas in the blood rush through this fine gauze towards each other and change places. The oxygen combines with the blood, making it red, and the carbon mixes with the air, giving it an unpleasant smell, and it is thus breathed out into the air.



Left Lung and Air Tubes.

Fig. 19.

We see, then, that to keep our blood pure, we want plenty of fresh air, so as to get as much oxygen as possible, and also to get rid of as much carbon as possible. To effect this, we require exercise, so as to quicken the circulation of the blood, and bring it as rapidly as we can to the lungs; and out in the open air, from which we can obtain the greatest amount of oxygen. If anything happens to prevent this interchange of oxygen and carbon, we should die in less than five minutes; and it is this which does happen, when people are drowned, or suffocated by the bad air of a room, as some-

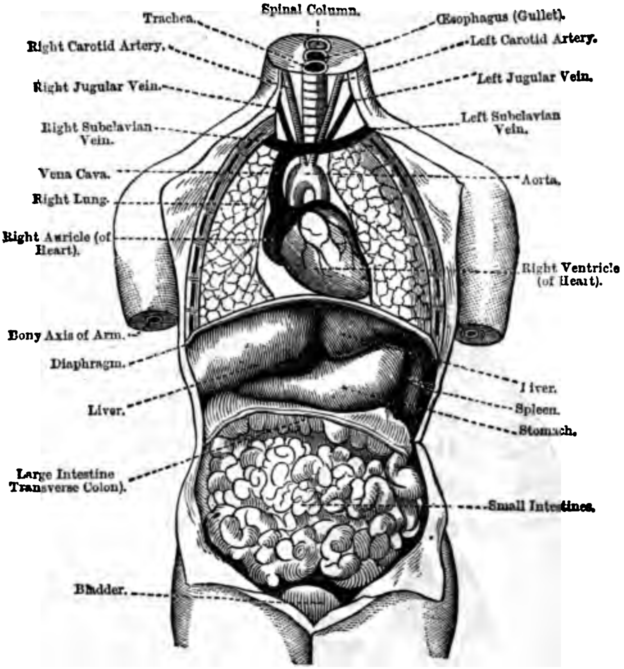


Fig. 20.

times is the case when they sleep in a room where charcoal is burnt, which fills the air with carbon.

The lungs are contained in a cavity or box, lying between the neck and the waist. It is protected in front by the breast bone, behind, by the backbone (or *spine*), and at the sides by the ribs, which are two sets of props encircling it, fastened at the back to the spine, in front principally to the breastbone, though the lower ones are only joined to one another, so as to allow of greater expansion of the lungs. There are twelve of these rib-bones on each side, fitted with a hinge to the back-bone, passing from the back to the front. They rather drop downwards, and the curved faces of the ribs hang flat towards the lungs (1); but when we draw a breath these faces are turned nearly straight outwards, (2,) twisting round a little on their hinges. This movement increases the size of the cavity, and by their being thus straightened they press out the breast bone sideways a little. thus enlarging the cavity from back to front; while at the same moment certain muscles draw down the elastic flooring (called the *diaphragm*)—which separates the circulatory and respiratory organs from those of digestion—thus lengthening the box perpendicularly, so that the movement of respiration increases its size from back to front, from left to right, and from base to summit.

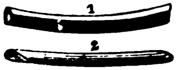


Fig. 21.

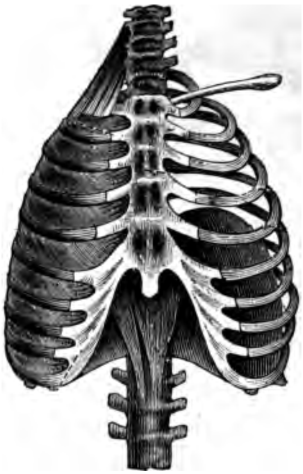


Fig. 22.

When, however, we speak of "drawing in a breath," we do not *suck in* air, as we do fluids from a drinking-cup. The air in the atmosphere is some fifty miles high, and its own weight forces it down wherever there is a vacuum. Put an empty can on the floor, and the air at once, by its own weight, presses into and fills it. It is just the same with the cavity of the chest, which is an empty can, which the pressure of the air fills when the mouth or nostrils are open. If then by muscular action the cavity is enlarged, a greater volume of air rushes in, by its own weight, to fill the vacuum thus caused. Take a pair of bellows, and work the handles, drawing them asunder. As you pull the handles apart, the bellows do not *suck in* air, but it rushes in from the pressure of the atmosphere, pushing open the valve at A. You then draw the handles together, and force out the air by compression of the bellows.

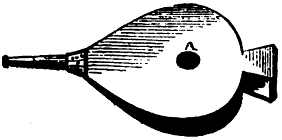
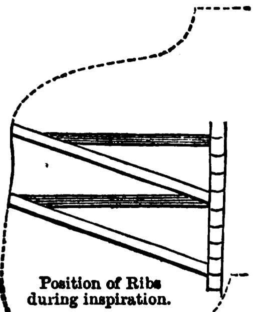
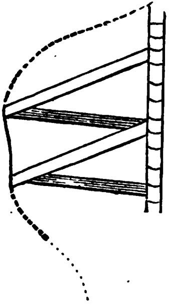


Fig. 23.



Position of Ribs during inspiration.



Position of Ribs during expiration.

Fig. 24.

We do much the same with the lungs. A set of muscles pulls the handles — the ribs —upwards, opening our bellows sideways, another set (like another hand) pulls down the diaphragm, lengthening the bellows downwards, and in rushes the air, till it has filled the enlarged cavity. Then the muscles relax, and let the diaphragm go back to its place, while another *set of muscles* pulls down the ribs, pressing out the air through the windpipe, just as we force it through the nozzle pipe of the bellows; but with this difference,—we can squeeze the two sides of the bellows quite close together, so as to get out almost all the air, but we cannot squeeze the ribs on our two sides together till they touch, so there is always a cavity in which some air is left, called "*residuary* air;" and by extra exertion, we can draw them out wider than we usually do, and so admit a greater amount of air, as when we speak of "drawing a long breath." You will have noticed, how, when you run, your breathing is much more rapid; you pant, and sometimes "get out of breath;" that is because the circulation of the blood is quickened by the exercise of running, and therefore the blood keeps coming into the lungs in quicker succession. So a more constant change of air is required to purify it, and the respiration is of course quicker. This shews that breathing during bodily exercise does more good than when we are sitting still.

THE BRAIN AND SENSES.

The centre of all sensation, as well as of thought, is the brain, placed, as we have seen, in the basin of the skull. It is the unseen governor of all our actions, which decides what is best for us to do; it is like the master in the school watching everybody and everything, and giving his orders what it is to be done next, and when to do it, repressing an action here, giving a warning there. But how can it watch, and know what is going on outside the body, when it is shut up close in the brain-pan?

It has two windows, the eyes; and two open doors for noise to reach it, the ears; and two smelling-bottles—the nostrils—to bring it bad smells; and two feelers—the hands—to tell the size, and hardness, and shape of objects, and some delicate little organs for testing the food of the body, situated in the tongue and back of the mouth. These are the organs of sense,

—taste, touch, smell, hearing, and sight; and all these carry intelligence to the brain of all that is going on around it. Then it turns all these over in its mind, and tells the various parts of the body, what to do. Suppose your mouth feels something put into it, or a boy offers you something to eat that you have not eaten before, those little pimples (*papillæ*) in your tongue touch it, and telegraph, as it were, by some little strings that go from them to the brain, that it is bitter or sweet, and the brain telegraphs back by other strings to the tongue to spit out the bitter stuff and to suck the sweet. These *strings*, as I have called them, are the nerves of the body, one set running from the organs of sense to the brain, and another from the brain to different parts of the body. The latter set communicate with the *muscles*, which are large bundles of flesh, having the power to coil themselves up, or contract (making themselves shorter and thicker) and the power to stretch themselves out again long and thin, or, as we say *expand*. When, for instance, your arm is stretched out at length, the muscle, A, in the upper part of your arm, is long and thin; but when you draw up your hand to touch your chin or your shoulder, that muscle is shorter and thicker. Stretch out your right arm, grasp the upper part of it with your other hand, and then double the right arm up and scratch your chin, and you will feel the muscle, A, in your right arm thicken, and rise like a lump.

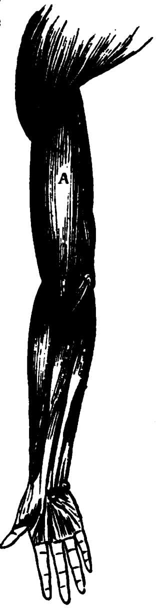


Fig. 25.

An illustration of a simple kind will shew you something of the way in which this is done. You have, no doubt, seen a snail crawling along the ground, it looks thin and long, with its horns stretched out. Just touch it with a bit of stick, it will draw in its horns, till they vanish in its head, and it will coil up into a thick, short ball.

It is very much the same with a muscle; the nerve is the stick that touches and gives it a sort of feeling that makes it coil up. You may have felt something of that kind all over your body when you have been frightened. I have seen a child coil himself up almost as a snail does at the sudden sight of something that has made him afraid.

TOUCH is the first sense used by a child, which begins to feel and handle, and so gets ideas of things before it realizes any of the other four senses. Touch is felt all over the body on the surface of the skin both inside and out; but it is not really the skin that feels, it is some little *papillæ,* as they are called, on the skin, which you may see on the palms of your hands and tips of your fingers, looking like little holes set in rows, like the little dents on the end of a thimble. It is to these that the nerves run, which carry ideas to our brains. The earliest impression we get is that a thing is hard or soft, according as it resists our pressure; then, that it is rough or smooth, cold or hot; next, that it is round or square and then we come to distinguish wood from iron, stone, or marble; to judge of size, and feel the difference between a piece of cord and a thread of fine silk. But all these judgments are the work of the brain, though practice teaches the fingers to detect even very minute differences, so that some blind men have so perfected their faculty of touch as to be able to tell accurately the *colour* of a number of skeins of wool by merely feeling them.

TASTE comes next, and is seated in the tongue and the palate at the back of the mouth. If you look at the surface of your tongue in a looking-glass, you will see some little dots on it like pins' heads, very much resembling those *papillæ* I spoke of in the hand. There are two kinds of these:—one like those on the hands, and for the same purpose, viz., to convey the sensation of *touch*; the other for the purpose of *taste.* These two senses are both exercised by the tongue, but they are quite distinct. Put a marble into your mouth, your tongue will *feel* (by its organs of touch) that it is hard, round and smooth; but it will not *taste* it at all; in fact, nothing can be *tasted*, unless it can be dissolved in water, *i.e.*, in the saliva of the mouth. So, if you put a lump of ice into your mouth, your tongue will feel by the *touch* that it is cold, and by *taste* that it is water and not milk. The object of this sense is twofold, *first*, to decide what is good for food; *secondly*, how much saliva is required to moisten it; so the taste tells us that a certain article is *nasty*, that we may either refuse it altogether, or, as in the case of medicine, take it only in small quantities; while, on the contrary, it pronounces others sweet, requiring a large quantity of saliva to commence their digestion, which, as we have seen with these substances, takes place in the mouth, not in the stomach, and immediately our "mouths water," as we express it.

Smell is exercised by the nose, which is divided into two chambers, called *nostrils*, by a thin gristly partition, on which there is spread out a very fine net-work of nerves, the branches of one great nerve (the *olfactory*) which runs straight to the brain. Any fine grains of matter, like dust, striking against this net-work set it *vibrating*, or all of a tremor, just like the strings of a piano when they are struck, or of a fiddle when the fiddle-bow is drawn across them. Now you know the feeling of vibration from the stinging of your hands sometimes when you hit a cricket ball with your bat, it

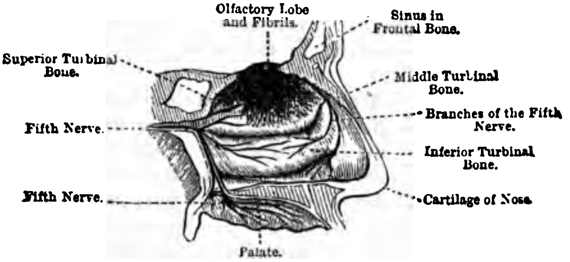


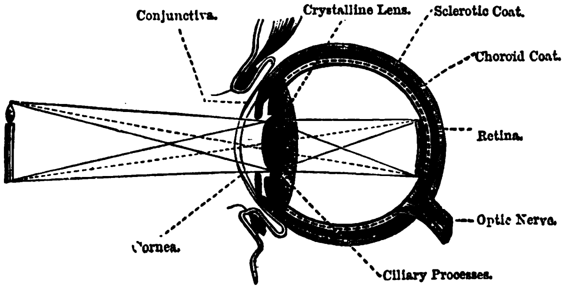
Fig. 26. Vertical Longitudinal Section of the Nasal Cavity. Showing Olfactory Lobe and distribution of the Olfactory Filaments, and the Fifth (Trigeminel) Nerve on the Right wall of the Nose.

seems to run all up your arm. When fine grains of dust hit these delicate nerves in the nose, they make it sting, and you feel a prickly stinging sensation right up into your head. Try with a bottle of smelling salts or some mustard. That is the vibration running along the olfactory nerve up into the brain; and practice teaches us to distinguish between the various kinds of vibrations, so that in time we learn to know what sort of things produce each of them, and without looking, we can tell whether we are smelling mustard or coffee. But we are not always conscious that there are any fine grains striking against our nostrils, as when we smell a flower. We must not wonder at that, as they are often too small to be seen; yet if you look at a ray of light shining into a room, you will see thousands of little specks of dust floating in the air, that you never see at other times.

The use of smell is partly to guide us in the choice of food, and partly to keep us from poisoning our blood by breathing foul air. Were it not for this we should stand without discomfort over a cess-pool, and keep our windows shut, when all the air in the room was poisonous, and so be inhaling air that was killing us or giving us fevers.

SIGHT is the effect of another vibration acting upon the *optic* nerve, and is caused by the effect of light. The optic nerve is a branch of the brain, running off in two arms, one to each eye. It pierces through the bone at the back of the socket of the eye, near the nose, and then is distributed over the skin of that socket in a sort of net-work (like that of the olfactory nerve), and this net-work is called the *retina*, which is like a mirror, placed behind the eye, receiving the objects upon it that are in front of the eye. The eye itself is only a little machine, like that box which is used by photographers to take views or likenesses. If you have your likeness taken, you stand in front of that box, opposite to a round hole, which is covered at first with a lid. When you are properly fixed, the photographer takes off the lid, and the light shining all round you, leaves your *shadow* on the glasses in that hole.

These glasses reflect your image through the box to a plate of glass behind, and, after a few minutes or seconds, your image is printed on the glass. The retina of the eye is like that plate of glass, and your eye is the box with the round hole and a glass (*lens* we call it), fixed behind the hole. But the retina is much more sensitive than a plate of glass, so it receives the image in front instantly, and this reception of the image on it, sets the roots of the optic nerve quivering and vibrating, and so they telegraph to the brain that something is in front of the eye; and by practice we learn to know one object from another. But our eyes are not glass, they are water, and you can tell for yourselves, that water will do as well for this purpose as glass, by looking at yourself in a basin of clear water, or looking into a pond or pool, in which you can see the trees, houses, or other objects around reflected, just as if it were a looking-glass. These objects are really impressed on the bottom of the pool (as they are on the retina of the eye), and not on the surface of the water.



Showing the formation of *inverted* optical images on the Retina at the back of the Eye.

Fig. 27.

HEARING is the sense exercised by our two ears, and is also caused by vibrations. I dare say you have thrown a stone into a pond, and you have noticed that where it falls into the water it makes a splash, and as soon as the splash has ceased, you have seen a ring all round the hole, where it went in, and this ring has gone on widening, larger and larger, till it has got to the edge of the pond. The same thing happens in the air (which is a liquid like water). An object strikes the air and causes a *concussion,* which sets the air vibrating, just as a stone thrown into the water disturbs the water. The air, too, vibrates in rings, spreading wider and wider, till they are lost to our ears as the rings of water are to our eyes. When any of these rings come within the range of our ears, part of the wave of sound goes into the ears, up the external *meatus,* pressing in a piece of fine skin, the *membrane Tympani,* fitted at the end of it, like the parchment over the ends of a drum. Fixed to the inner surface of this drum-head is a little bone (called the *hammer*), working on a hinge, with another little bone (the *anvil*), which with a third (the stapes, or *stirrup*), form a sort of

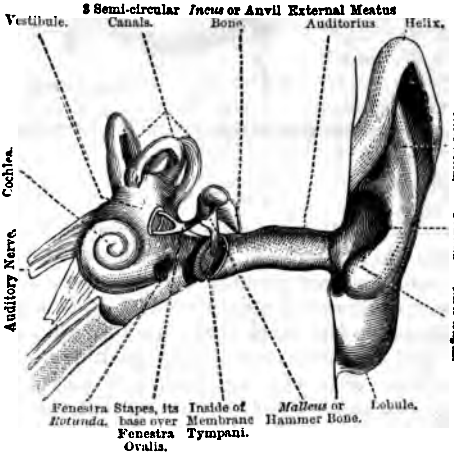


Diagram of Ear.

Fig 28.

crank which presses inwards another piece of skin, covering a chamber, called the *vestibule,* to which are attached the semicircular canals, containing water and sand. When the wave of sound pushes in the skin of the drum, it works the crank, which pushes in the inner skin, and sets all the water in the bags moving, and shaking all the grains of sand. These little grains knock against the fine ends of the *auditory* nerve, (just as the grains of matter do on the olfactory nerve), and make them vibrate; so the sound is carried to the brain. A very curious little instrument called the *cochlea,* or shell, like a very small piano, with different keys, is attached to these water-bags, and different sounds touch different

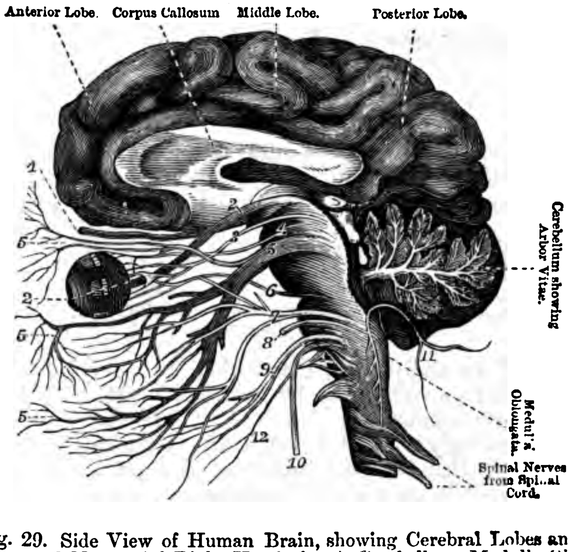


Fig. 29. Side View of Human Brain, showing Cerebral Lobes and Cranial Nerves (of Right Hemisphere), Cerebellum, Medulla Oblongata, and Corpus Callosum.

The observer is supposed to be looking at the right side of the great Longitudinal Fissure, and the *cut* portion of the *Corpus Callosum.*

keys on it, and so set different strings of the auditory nerve vibrating, and it is this contrivance which enables us to distinguish accurately one sound from another, and one note of music from another. The drum is kept full of air by a tube, passing from the throat, which carries on the vibration. Those who are deaf from any disease in the outer tube of the ear, of the small bones, or of the membrane covering the drum, are still able to gain some sense of hearing through this tube, and by clenching with the teeth the wood of a musical instrument, for instance, they can enjoy the music played upon it.—*Rev. J. Ridgway.*

WHOLESOME DRINK.

If we were to separate the solid matter of our bodies from the liquid, we should find that a full grown healthy man of average size, weighing about 10½ stones, contains—

	lbs.
Mineral matter, *for the bones,*	9
Fat, *for heat,*	5½
Flesh, *for movement,*	15½
Water, *for moistening the tissues and transport of blood,*	115
	145 lbs.

So, if we analyze the blood which is to replenish this body, as it wastes away by exercise, we shall find the same proportions,—*i.e.*, in every 20 lbs. of blood, we shall find only about 4 lbs. of solid matter and 16 lbs. of water; so that we have four times as much water in our bodies and in our blood as we have of all other substances put together.

We are all very eager to eat, when we are hungry, and if people cannot eat, they think they are very ill, and begin to fancy themselves very weak; but they only want one-fifth as much food as they do liquid. Some people drink a great deal. Some drink beer, some spirits, and others wine; and because these drinks contain something more than water, which seems to give them a new life for a time, so that they can go on working at first with more power than they could just before, they fancy they have taken something that gives them strength, and that there is *nourishment* in beer, wine, and spirits. Let us see if it is so.

I. We want something to dissolve the solid food we eat, and make it into a very thin liquid, so that in the shape of blood it can run through those very fine tubes, like hairs, and carry nourishment to every part of the body. The only liquid that will dissolve solid food is *water*. Take a piece of cooked meat, and put it into a bottle of water, and place a similar one in a bottle of brandy, and see the difference. The former will soon be dissolved (especially if you shake it about), but the other will become dry and shrivelled, as if put into an oven, but will never dissolve. The first thing we want, when we have eaten our food, is to digest it as quickly as possible, and send it over the body to renew the wasted parts, and give us new strength. Before it can be digested, it must be dissolved and made into a liquid, like milk; but, as only water can do that, if we drink spirits with our food, we are putting what we want dissolved into a bottle of spirits, as you may sometimes see frogs and little snakes preserved in spirits in a doctor's surgery.

If we drink beer with our food, it is only the water in the beer that dissolves the food; and all that gives the beer its *strength*, as we call it, is a kind of spirit which stops digestion, until the stomach has got rid of it. The reason why we feel an effect from it immediately is, that our body does not want it, and tries to get rid of it; so the little veins in the stomach suck it out; but the blood does not like it, and so runs away with it, as fast as it can, to the lungs; and the breath smells of beer, or of spirits, and the fat is set on fire by it, so that heat is made, which opens the pores of the skin, and some is got rid of in that way, and the rest by the action of the kidneys.

All this shews:—(1.) That the body does not require it or use it for the purpose of renewing its own waste and (2.) That it burns up some of the store of fat we want for use in the body; and, as it cannot burn without using some of the oxygen in the blood, just as a fire, you know, will not burn without the oxygen of the air, it follows that such drinks carry off some of that very oxygen that gives us *force*, and so really diminish our power of work, after the first few minutes. So, when the strength of the spirit is gone off, a man feels himself weaker, and he wants more, until he soon uses himself up for that day.

When we want water, we feel *thirsty*. Now, what is it that causes thirst? It is the dryness of the skin lining the mouth, throat, and stomach: so that to *quench* our thirst, we must drink something that will moisten that dry skin. The word "quench," which we use, shews that this dryness comes from some burning heat within us. Take a tea-spoonful of brandy, and hold it in your mouth. Does it moisten the skin, or quench any heat there? No, it makes it burn, and smart, and blister, till the skin peels off. Well, if you drink it, even when mixed with water, it will do the same by your throat and stomach, and they will feel dry and parched, and make you feel more thirsty. But drink a glass of pure cold water, and your thirst is gone, your throat is moist, and your food digests.

So we find water is the most wholesome drink:—

1. Because it alone dissolves food in the throat and stomach.
2. Because it assists all the functions of the body.
3. Because it forms all the fluid of blood.
4. Because it forms the only real liquid in the body.
5. Because it alone takes up the decomposed particles, and conveys them from the body, by the system of sewerage, through the lungs, pores, kidneys, and intestines.

II. That spirituous part of various drinks used by men is called *alcohol*, a name given to it by some Arabian chemists, who first discovered it. Alcohol is caused by fermentation, and is really made out of sugar in a process of decomposition. It is a liquid, and easily mixes with water; in fact, it is hardly possible to get it without some water being mixed with it. What we usually call "spirits," as whisky, rum, brandy, and gin, have little water in them, more than half being alcohol; so we say, they are *strong;* but what do we mean, when we call them *strong*. We do not mean, that they give *us* any strength; but that there is a great proportion of alcohol in them *compared with the water,—i.e.*, they are *strong* in alcohol, just as we say, when a man has been drinking spirits, that his breath smells quite *strong* of brandy, &c.

But do not they give us any strength? Many a person thinks he cannot go on working (especially if his work is very hard) without a drop of something strong, or a glass of beer, to give him strength; and when he has had it, he smacks his lips, and says, "There, now, I can go on;" and he feels to have new life in him, and for a short time he does work more quickly. Now, let us see why this is. If he were to eat some bread and meat instead, and drink a glass of water, it would take a little time before any of the food were dissolved and digested in his stomach, so as to find its way into his blood, and circulate about his body, and refresh him with new strength. All substances that are *thoroughly dissolved* in water are taken up into the vessels of the stomach as quickly as water itself; so spirit, being thoroughly dissolved in the water, finds its way into the blood as soon as it is swallowed; and as the blood does not want it, it circulates, as fast as it can, to get rid of it. The same quick circulation takes place after the food has found its way into the blood, because the circulation is intended by nature to carry refreshment to each part of the body. When a man has drunk his glass of brandy and water, it begins to circulate rapidly in his veins, and he feels very much as if he had digested a good dinner. It has produced heat in his blood, and consumed some of his fat. Now, we have learnt before, that this burning in the blood produces force; therefore, he feels strong and able to use great force, and when he gets partly drunk, he often commits acts of great violence.

But has he gained any strength? No, not a bit; he has drawn a great deal of *spare* force out of himself. I dare say, you have sometimes thought you could get home from school faster if you ran all the way, and have offered to run a race with another boy to get you along quickly. Well, you might do so, if it were for a short distance; but supposing you had three or four miles to go, how would it be then? You would both run as fast as you could, perhaps for a mile, and leave all your companions a long way behind. Then you would get out of breath, feel very hot and very tired, and sit down on the road-side to rest yourselves. You would feel you *could* not go any farther, and you would rest till the companions you left behind overtook you, and still you would want to rest longer, while they seemed cool and fresh and ready to go on.

That is just like what happens to a man when he drinks fermented liquor at his work. He runs hard for half an hour or so, and then he begins to get hot, and tired, and wants to rest. He must either have some more drink to set him off again, or he goes lazily through his work. He has used up some of his spare strength, and has not added any to his stock. Any one who thinks about it, will find in himself that this is true. He will notice that he can go on at a good steady pace all day, and do a very good day's work, if he eats his meals of good nourishing food, and drinks water enough to dissolve it; but if, instead of eating solid food, he takes a glass of spirits, he can only work a short time at full speed, and then must go only half-speed the rest of the time.

Now, let us see if this is the case. You will hear a man say, when he is hay-making, that he must have some beer, it is so *hot*. Then, on a winter's day, a labourer comes out of the field and wants some beer, because he is so *cold*. There is some truth in both of these. the one feels *dry* and parched, because he has lost a great deal of moisture from perspiration, and his blood is less liquid than it ought to be; the other is cold, because he has parted with heat by evaporation and his blood circulates too slowly; the latter wants *warmth*, the former *moisture*. But there is no alcohol in the blood naturally, *water* is what it wants; and, as we have seen, the alcohol only heats the blood, which on a hot day requires to be cooled. Any man who works in a shop where they smelt iron and steel, or in those great forges where the large iron plates are rolled out, that are now fitted on to our iron-clad men-of-war, knows very well he *could* not endure the great heat at his work, if he were to drink even beer; so, if you were to go into any of those works at Sheffield, you would see the men, pouring out melted steel, with very little clothing on, their breasts all exposed, and running with perspiration; but they never drink beer at their work, only any quantity of cold *tea.*

But, why is it that tea is better for men so employed than beer? They must lose a great deal in the form of perspiration, when they work in such a hot place. We generally think that excessive perspiration *weakens* people; but we do not really get weaker in the hottest part of summer than we do in the coldest part of winter; we are really weaker, more liable to illness, colds and fevers, in winter than in summer. The weakening, then, of our bodies from perspiration depends upon the composition of the sweat (as it is commonly called) which comes through the pores of the skin. If it is only water, we only lose water; if it contains decayed matter from the body, mixed with the water, we lose that amount of the substance of our frames together with the water. When perspiration is caused only by *external* heat, we lose scarcely anything but water. Now, let us see what is the composition of tea. It contains a substance which it draws up from the soil, in which the plant is grown, on the hills of China under a very hot sun. If you take a little tea, powder it very fine, then put it into a small plate in the oven, and cover it entirely over with a piece of paper, twisted into the form of a sugar-loaf, as soon as the powder has become very hot, a vapour will rise from it and settle on the inside of the paper. Now, take the paper off and hold it to the light. You will see it is covered over with a very fine powder, shining in the light like powdered white sugar. This is the *substance* of the tea to which I referred. You will find 3 grains in every half ounce of pure tea, or 1 lb. in 50 lbs.

This white substance is found to have a very wonderful power of *sustaining* man's strength, and of making food, eaten with it, go one-fourth further in keeping up his strength than if the same food were eaten alone, so that 3 or 4 grains of it are enough for one day. It has been found, by experiments, that if a man eats half a pound less bread a day, but adds half an ounce of tea instead, he does not miss the loss of the bread. So those iron-smelters, by drinking tea, retain this white substance, which keeps up their strength, and stops the waste of the flesh of their bodies, and they only part with the water, in which it is dissolved.

But tea has another valuable quality. This same white powder is *nerve-making* substance; it is better adapted than any article of food to strengthen the nerves and brain of man in active work; so those who study much, as well as those who live by the sweat of their brow, find tea the best refreshment of the waste of brain and nerve in following their studies, or sustaining hard bodily labour.

This same substance is to be found in cocoa and coffee; yet these two plants grow in a very different part of the world from that where tea is found. The coffee tree and cocoa plant will not flourish in China; but the former is cultivated abundantly in Arabia, Ceylon, and the West Indies, and the latter in Mexico and Peru. Nature thus stores up in various climates the nourishment man requires in all the avocations of life, to restore his wasted energies, and enable him to "go forth to his work and to his labour until the evening." It is not without some purpose for our good, that so large a tract of China is covered with tea-bushes,—an extent of country almost as large as Wales, three millions and a half of acres! And it is only because it does supply a natural want of mankind, that we can account for the rapid spread of the use of tea, which only 200 years ago was unknown in England, but is now regarded as a necessary article of consumption by more than half the inhabitants of our globe, who consume no less than 3,000,000,000 lbs. every year!

But may not the same be said of beer? It is made from barley, which is a natural product given to us for our daily food, and it contains a large amount of nutritive substance, just as does the wheat, from which bread is made. Well, perhaps, if we made tea out of barley just as we brew it out of tea-leaves, it might be as good as porridge; but in making beer, we decompose the barley, as may be seen by the fermentation (or *working* as it is called) of the liquor. First, the barley is roasted in a kiln to turn it into malt. That takes a great deal of the nutritive strength out of it, and it has a *sweet* taste, which shews that the starch is partially converted into sugar. Next, it is boiled in water which completes the change, (just as when masticated in the mouth and moistened with warm saliva, the main part of the conversion of bread into sugar takes place). But, the boiling is continued, until decomposition sets in, and it is then allowed to cool down to the necessary temperature to perfect this. It begins to *work*, heave up, froth, and ferment. All this is a sign of decomposition; gases escape from it, as from putrid matter. It is now in the ripe condition for intoxicating those who drink it, and it is closely fastened down in barrels before too much bad gas has escaped, and most of the putrid matter is kept in, mixed with the liquid. This essence of decomposition, which I have called *gas*, is alcohol, and is the product of sugar and water. All the nutritive element in the grain has left the beer, and only the water and alcohol remain. After this fermentation, it is no longer nourishing like porridge or milk, but it is poisonous. What do we nean when we say it is *intoxicating?* That word means *poisoning*. And it is poisoning, for it does what many poisons do: it spoils the blood, it weakens the brain and nerves, and it stops digestion.

But let us go to facts. Dr. Lyon Playfair has analyzed a specimen of "highly nourishing beer and stout," and reports that of blood-forming matter it contains exactly *one* part in 1,666 parts. Baron Liebig, in his *Chemical Letters*, states that the whole purpose of brewing is to get rid of the blood-forming elements of the grain, and to change the useful sugar into alcohol. We can prove," he says, "with mathematical certainty, that as much flour as can be laid on the point of a table knife is more nutritious than eight quarts of the best beer; that a person who is able *daily* to consume that quantity of beer, obtains from it, in *a whole year*, in the most favourable case, exactly the amount of nutritive matter which is contained in a five pound loaf or in three pounds of flesh."

If this is the case, as it certainly is, with pure beer, it is much worse with by far the greatest quantity that is sold at public houses under that name; for those who are in the habit of going there want something that will quickly make them feel its power, and the man who sells it wishes his customers to ask for more; and, therefore, a great many things are put into it to make it more intoxicating, and to burn up the tissues that line the throat and stomach, creating more thirst the more a man drinks. So any one may drink till his throat and mouth are quite dry, and hot, and parched, and his tongue is inflamed, dry, and swollen, till he cannot speak plainly. The next day he has a dreadful headache, because his brain is inflamed with the poisonous alcohol he has poured into his blood. But drinking ought to cool the blood, moisten the tissues, and quench thirst. It is very clear that drink containing alcohol does just the opposite, and *increases* thirst.

But some people think there is nourishment in it, because people get fat upon it. If you notice, you will find that some people get fatter as they grow older, and some get thinner. The fact is that both fat and leanness are signs of the decay of our bodies. In some constitutions decay takes the form of fat, and in others of waste. So one man who drinks becomes very fat, while another becomes very thin: both shew that the poison is doing its work, and its victim is hastening too soon to his grave.—*Rev. J. Ridgway.*

ON STIMULANTS IN SICKNESS.

However bad alcohol may be in times of health, when people do not want it, yet very many think it is a very good medicine in illness. Now, our bodies are very much the same as those of other animals. Man is the only cold-blooded animal that ever drinks anything else to quench his thirst but water. And in sickness we do not run for the brandy bottle to give a dose to our horses, cows, pigs, and sheep, as we too often do to ourselves. When we do, it is only in extreme cases, such as poisoning, when we want to quicken the circulation and get rid of the poison from the blood. In all other cases we know the animal will stand a better chance with other treatment.

But with ourselves, if any one is faint, we give them spirits; if they are burning with fever, we pour more fire into them to increase it; if they are sinking with consumption, we offer port wine to burn up the small particles of fat that still remain in their wasted frames. It seems to give them a little new life, because it quickens the circulation, dries up the moisture in the lungs, and stops the cough, but only to make them sink lower, as soon as the effect is gone off. No animal life can possibly be *supported*, though it may for a time be prevented from extinction, by stimulants, since they only make it run on, as it were, at express speed over a dangerous chasm; but this can only be done at the expense of a most violent strain upon the whole machinery, which will leave behind it a lasting injury for life.

A very eminent physician of Guy's Hospital, in London, writes in the following forcible language on this use of alcohol in cases of illness:—

"It causes me daily surprise to observe how the effects of stimulation are overlooked. Often have I been called to see a patient apparently dying, sometimes of a nervous disorder, at another time of a liver complaint, and at another of heart disease. He is lying in bed, where he has been for some time, and kept alive by brandy; the breath is abominably fetid; the heart's action is so rapid that it is impossible to say whether the organ is diseased or not; the patient refuses food, or if this be taken, it is rejected, and so he is plied with brandy to keep him alive; the body is, in fact, saturated with spirit, or its elements. My first remark on seeing such a case is, that a man cannot live on alcohol; he must take some food or he will die. The correctness of such common-sense remarks is admitted, but qualified with the statement that no solids can be taken, and that if stimulants be omitted it is feared the patient will sink. It is assumed that the constant administration of brandy is necessary for the temporary maintenance of life, and the idea never seems to have been conceived that the stimulation of the heart causes the weak, fluttering pulse, and stimulation of the stomach a subacute disease. Do you ask me what method I adopt? The simplest possible. I withdraw every drop of the stimulant, and in a few hours the irritated stomach is partly restored to its normal condition, the nervous excitement abates, the patient takes a little food and begins to mend. Do you ask, again, whether I do not fear any frightful results from the sudden withdrawal of the stimulus? I say, not the least; I have no fear of the consequences.

"That many cases of disease of various kinds would do far better without stimulants I am perfectly confident. But lately I have seen the case of a gentleman, about sixty years of age, who passed through a most severe attack on the lungs without the use of stimulants. He had been a tolerably free liver, and would not have been called a good subject; but having before me the case of another gentleman of the same age, who had just died of a similar attack, and who had taken a large quantity of brandy, I readily acquiesced in the patient's own view, that none should be given. It is very remarkable what extremes we have reached, and on how slight a scientific basis is founded the treatment of such diseases. Not many years ago the opposite method was adopted, including bleeding, antimony, calomel, &c.; then came the "let alone" method; and now we have the brandy treatment. What the need of this can be with Professor Hughes Bennett's statistics before us, I do not comprehend. My own opinion is (but of course this is only an opinion), that in any given number of cases a larger majority would recover under the old treatment than by the more modern method by brandy. As regards heart disease, the utmost discrimination is required in the use of stimulants. There are cases where an undoubted benefit is produced by them; but there are others, and these I have seen repeatedly, where alcohol has induced palpitation, fluttering, great distress, and constant sleepless nights, but where, on the other hand, the withdrawal of the spirit, and the substitution of a dose of medicine has been of the most essential service.

"Of course stimulants are often needed as medicines; but young persons with typhus and typhoid fevers are far better, I believe, without them. That they make good recoveries on simple milk diet is a fact, which my hospital cases prove, and which no *arguments* can gainsay; and, on the other hand, I have seen a marked improvement take place in some cases where a stimulus has been left off. It is also a fact that in bronchitis I have repeatedly seen improvement after stimulants have been omitted; and, as regards heart disease, I am convinced that the amount of mischief done by stimulants is immense. In the case of fever and bronchitis, the weak pulse is often but an indication of extreme capillary congestion, and a stimulus to the heart only aggravates the evil; and in the case of a diseased and weak heart, where *repose* is indicated, a constant stimulation by alcohol adds immensely to its trouble.

"Whatever may be thought of the remarks just made, there is one thing which I must insist upon—that is, when treating any malady, and the administration of alcohol is suggested to your mind, that you give the same grave consideration to its recommendation as you would to any other potent drug; not to sit down and give all your serious thoughts to the question of whether a grain of this or a grain of that drug should be ordered, perhaps twenty or thirty drops of either, and then at hap-hazard order any loose number of ounces of brandy. You observe, that I say nothing against the potency of alcohol in several states of disease; but I do speak strongly against its indiscriminate use without due consideration of its need or of its results. My arguments would equally apply did I find that opium or any other drug were indiscriminately used as a universal medicine. I should protest against the practice, whilst still possessing great faith in the virtue of the drug. If I can influence you to place alcohol in your list of drugs, so that you may administer it with the same caution as you do the several powerful drugs used as medicines, then the object of these remarks will be fully answered."*

In the *Lancet* of March 12, 1864, there was an article on "Facts and Conclusions as to the use of Alcoholic Stimulants in Typhus Fever," by W. T. Gairdner, M.D., Physician to the Royal Infirmary, and Professor of the Practice of Physic in the University, Glasgow. Dr. Gairdner shewed that the mortality from typhus fever might be greatly reduced by reducing the quantity of alcoholic stimulants usually given; that this reduction in mortality may take place at all ages, but in a marked degree among the young; that the young and temperate persons may be advantageously treated, with a diminished mortality, *without one drop of wine or spirit being given from beginning to end of the fever, except in the rarest casualties.* The reduced mortality under Dr. Gairdner's mode of treatment is highly encouraging. It appears that in 595 cases of all ages treated by Dr. Gairdner, the mortality from typhus was only 11·9 per cent.; whilst under the liberal use of stimulants the mortality for all ages was 17½ per cent. These results are extraordinary, as the average mortality from typhus in the hospitals of England is little less than 18 per cent. It is well known that typhus fever is not so fatal to the young as to adults, and we see that in 189 unselected cases among the young treated by Dr. Gairdner *without stimulants* the mortality was less than 1 per cent. Dr. Gairdner says—"I confess I am strongly persuaded that, to the young, in typhus, and very probably in most other fevers, stimulants are not less actively poisonous and destructive, unless administered with the most extreme caution, and in the most special and critical circumstances." He further shews that, had the 189 young persons formerly mentioned been in the hands of the late Dr. Todd, under a routine of such extreme stimulation as is indicated in Dr. Todd's book on Acute Diseases, it seems probable that instead of one death in the 189 cases, there must have been no fewer than thirty to thirty-five.

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* A Lecture on Alcoholic Stimulants in Disease. By Samuel Wilks, M.D., Physician to Guy's Hospital, and Examiner in the Practice of Medicine at the University of London.

Many medical men will confess that by ordering the use of stimulants in sickness, they have unintentionally sown the first seeds of drunkenness. Too many of their patients, relying on medical advice, have begun the habit of drinking, which has not ceased when they have left off the other medicines prescribed, but has continued, increasing almost daily in the amount taken, until the habit has become confirmed, and their lives sacrificed at an early age. Here is the testimony of one*—"I believe I have made many drunkards, not willingly, not purposely, but I have recommended the drink. It makes my heart ache, even now, to see the mischief that I have made in years gone by, mischief never to be remedied by any act of mine. But in this respect at least I do not sin now, and have not done so for the last ten years. I do not take intoxicating drink myself, I do not have it in my house, and I do not give it to anybody else."—*Rev. J. Ridgway.*

HÆMORRHAGE; OR, LOSS OF BLOOD.

THE escape of blood from its vessels into the surrounding tissues is named *extravasation;* if into one of the cavities of the body, or externally, it is named *hæmorrhage.* The loss of from four to six pounds of blood, from one or more of the great vessels, will generally prove fatal to an adult, but if the bleeding be slower, much larger quantities may be drawn from the blood-vessels without a directly fatal issue.

Death from sudden hæmorrhage, is caused by the want of sufficient blood to supply the nervous centres, so that fatal *syncope* (*i.e.*, fainting), takes place. When death occurs from prolonged hæmorrhage, it is not from a defective supply of nutriment to the tissues generally, but from a slow exhaustion of the nervous and muscular power, affecting the brain, spinal cord, and heart, due to a deficient supply of nutriment and of oxygen to them, in consequence of the diminution in the number of the red corpuscles.

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* Henry Munroe, M.D., F.L.S.

Everyone should be acquainted with the various forms of accidental bleeding, and their immediate treatment. If it be *general oozing* from small vessels, which is easily recognized, and if it proceed from a part to which pressure can be applied, a handkerchief closely folded into the form of a pad, and firmly bound over the spot by another handkerchief, will generally suffice to staunch the bleeding for a time; the part should then be kept elevated and at rest. In hæmorrhage from a *vein* the blood is dark, and the stream flows continuously, welling up over the surface. Moreover, pressure with the finger on the side of the wound further *from* the heart will almost entirely arrest the bleeding; whilst if pressure be applied on the side of the wound *next to* the heart, the flow of blood becomes more copious. To arrest bleeding from the veins, a small thick pad should be applied upon the wound, so as to extend a little to the side further from the heart; this should be firmly secured by a handkerchief or bandage; the chief pressure must be made on the side of the wound away from the heart, because that is the direction from which the blood flows. *Arterial* hæmorrhage is known by the blood being bright, and projected in a jet from the wound, sometimes to a considerable distance, usually by jerks; though, if the artery be very small, there are merely slight intermissions in the force of the jet, and, in wounds of very minute arteries, the jet is continuous. Moreover, pressure, on the side of the wound further from the heart, has no effect on the strean ; but pressure on the side nearer the heart stops it. To stop arterial bleeding from a small artery, therefore, a pad of suitable size should be applied upon the wound, and extend also on the side *next* to the heart; it must be not merely *firmly*, but *tightly* bound by a handkerchief or suitable bandage. If the artery be large and deep-seated, very forcible pressure becomes necessary; and in order to communicate this specially to the artery itself, a small, thick, and unyielding kind of pad is necessary. This should be made not by *folding* a handkerchief, but by *rolling* it up as tightly as possible, with or without some firm substance enclosed in it. A pebble or a bit of stone, wrapped up in a piece of paper, may be placed over the artery; a pocket handkerchief tied round the limb, and twisted tightly with a stick passed through the handkerchief on the side of the limb *opposite to* the wound, will increase the pressure and stop the bleeding. Great care must be taken to keep the wounded person laid down until this has been done, and he should then be *carried* home on a stretcher, a hurdle, or a door, and on no account be allowed to walk or stand, if the wound should be in the leg or the body.

These directions apply to veins and arteries situated in the *limbs*. Upon the *head*, simple pressure with the thumb or finger will suffice to stop bleeding from either kind of vessel, because the bones of the skull afford a perfect means of counter-pressure. A little cotton wool, cob-web, nap of a hat, will all help to stop bleeding from a small surface wound. A cut of the large vessels of the neck requires very special management; but, as a general rule, direct pressure with a pad, kept in its place by the thumb, is the best means to adopt until proper assistance by a medical man can be procured.—*Marshall's Physiology.*

To stop bleeding from the nose, the quickest remedy is to hold the head over a basin, and get some one to pour cold water on the back of the neck, or even down the spine. If this should fail, lay the person flat on the back, plug the nostrils with cotton wool, roll up a strip of paper into the size of a small piece of slate pencil, and put it under his tongue. Let him lie there perfectly still until the doctor comes.

POISONOUS GAS IN WELLS.

A SAD accident lately happened, which shews how much ignorance prevails with regard to the danger of going down into wells, and also respecting the means by which that danger may be discovered and prevented. It seems that a poor man, who was engaged in sinking a well, went to his work in the morning as usual, was lowered down by his wife and another labourer; but, on reaching a certain depth, became unconscious, and fell into the water below. A neighbour, who keeps a nursery-garden, hearing the screams of the wife, ran to render assistance, instantly descended, with the vain hope of being able to rescue the labourer, but, in reality, of course, only to share the same fate. A brother of the latter then descended; but fortunately had first a rope strongly fastened to his body. He also became unconscious, but was hauled up by the rope, and recovered. The previous victims were raised after a time; but in both of them life was extinct.

Now, it cannot be too widely known that such calamities as these, which cannot be called *accidents*, are caused by the presence in the well of carbonic acid gas, which has found its way there from some rift in the strata of rock that has been cut through, and which sinks by reason of its weight. This carbonic acid gas is what is called by the miner "choke-damp." No one should ever descend into a well without first lowering down into it a lighted candle. On reaching the carbonic acid gas the candle goes out; and when this happens, human life will also be extinguished, if a living person be lowered into it. No one ought, therefore, to go down until this gas has been pumped out, which is easily done by pushing down a bundle of straw or a sack of hay or shavings, and hauling it up again, several times, until the air is changed, and the candle will burn when lowered to the bottom.—*From the Lancet.*

It is pitiable, in these days of general knowledge, to read of the lives of brave men being uselessly sacrificed for want of information that should be within the reach of every National School-boy. A correspondent of the *Times*, in commenting on the above accident, says:—"It has often occurred to me, that if the Government training for National Schoolmasters were made to comprehend instruction in simple emergency remedies, such as the treatment of suspended animation, temporary stoppage of bleeding, and such other relief as is frequently called for by the accidents that befall labouring men, many lives might be saved, which now are lost; for the witnesses of an accident would know that there was some one whose duties always keep him on the spot to whom they could apply for help; while, by imparting this simple knowledge to his scholars, a number of men would be educated into fitness for any emergency, and by these means good use could be made of the time generally lost before the arrival of a medical man, who may be miles off at the time of the accident, so that the latter would not so often find, on seeing the sufferers, that his assistance had come too late."

REWARDS FOR SAVING LIFE.

AT a meeting of the Royal Humane Society, on the 19th inst., the following cases of personal bravery in saving life were brought before the notice of the committee and rewarded:—The silver medallion was unanimously voted to Sub-Lieutenant G. H. Yonge, of Her Majesty's ship Bellerophon, for saving, on the 7th of February last, Alfred E. Martin, ship steward's boy, of Her Majesty's ship Northumberland, who was capsized from a launch into 20 fathoms water at Lisbon. The second launch of Her Majesty's ship Northumberland, while under sail, was carried by the tide foul of the Bellerophon's starboard swinging boom, and instantly capsized. The ship steward's assistant, who had been in the boat, shouted loudly for help as the five-knot tide swept him past. His cries were heard by Mr. Gustavus H. Yonge, who was lying down in the gun-room of the Bellerophon, suffering from rheumatism. Although dressed in a heavy suit of flushing at the time, which necessarily much impeded his swimming, Mr. Yonge, without a moment's hesitation, or staying to divest himself of any of his clothes, sprang from the gun-room port into the water to the assistance of the drowning man. After great difficulty, he, with the aid of a life-buoy which was thrown overboard, at length succeeded in reaching Martin, and supported him round the waist until they were both picked up and taken on board. Both were much exhausted, having been in the water several minutes.—On the recommendation of the Earl of Kimberley, the Society's silver medallion was also given to Charles A. Smith, nine years of age, for saving his brother, a baby, who had accidentally fallen into the River Yarra, at Melbourne, Victoria, on the 13th of December last. It appears that the attention of the mother of the child was suddenly excited by cries of alarm from the opposite side of the river, raised by a gentleman who saw it fall into the water, and upon running down the garden to the margin of the stream she discovered that her youngest child, some 18 months old, had fallen into the water, and was drifting rapidly away with the strong current. Her son Charles, who was just learning to swim, had, fortunately, also heard the alarm. Without an instant's hesitation, he sprang in to the aid of his brother. Reaching him, he managed to keep himself and his burden afloat until a semi-submerged snag caught them and providentially arrested their progress. Here he held on, and an inward turn of the current having by this time swept them somewhat nearer the bank, the mother was enabled, by wading in herself waist deep, to catch her son by the hand, and draw him and the baby to the bank.

DIRECTIONS FOR RESTORING THE APPARENTLY DROWNED.

THE leading principles of the following Directions for the Restoration of the Apparently Dead from Drowning are founded on those of the late Dr. Marshall Hall, combined with those of Dr. H. R. Silvester, and are the result of extensive inquiries which were made by the Life-Boat Institution in 1863–64 amongst Medical Men, Medical Bodies, and Coroners throughout the United Kingdom. These Directions have been extensively circulated by the Institution throughout the United Kingdom and in the Colonies. They are also in use in Her Majesty's Fleet, in the Coast Guard Service, and at all the Stations of the British Army at home and abroad.

I.

Send immediately for medical assistance, blankets, and dry clothing, but proceed to treat the Patient *instantly* on the spot, in the open air, with the face downwards, whether on shore or afloat; exposing the face, neck, and chest to the wind, except in severe weather, and removing all tight clothing from the neck and chest, especially the braces.

The points to be aimed at are—first and *immediately*, the Restoration of Breathing; and secondly, after breathing is restored, the Promotion of Warmth and Circulation.

The efforts to *restore Breathing* must be commenced immediately and energetically, and persevered in for one or two hours, or until a medical man has pronounced that life is extinct. Efforts to promote *Warmth* and *Circulation*, beyond removing the wet clothes and drying the skin, must not be made until the first appearance of natural breathing; for if circulation of the blood be induced before breathing has recommenced, the restoration to life will be endangered.

II.—To Restore Breathing.

To Clear the Throat.—Place the patient on the floor or ground with the face downwards, and one of the arms under the forehead, in which position all fluids will more readily escape by the mouth, and the tongue itself will fall forward, leaving the entrance into the windpipe free. Assist this operation by wiping and cleansing the mouth.

If satisfactory breathing commences, use the treatment described below to promote Warmth. If there be only slight breathing—or no breathing—or if the breathing fail, then—

To Excite Breathing—Turn the patient well and instantly on the side, supporting the head, and

1.—*Inspiration.*

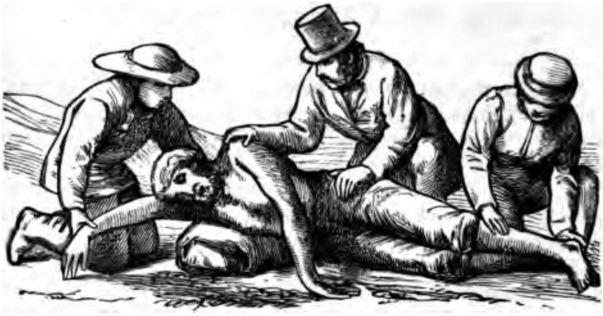

Fig. 30.

Excite the nostrils with snuff, hartshorn, and smelling salts, or tickle the throat with a feather, &c., if they are at hand. Rub the chest and face warm, and dash cold water, or cold and hot water alternately on them. If there be no success, lose not a moment, but instantly—

To Imitate Breathing—Replace the patient on the face, raising and supporting the chest well on a folded coat or other article of dress.

Turn the body very gently on the side and a little beyond, and then briskly on the face, and back again, repeating these measures cautiously, efficiently, and perseveringly, about fifteen times in the minute, or once every four or five seconds, occasionally varying the side.

[By placing the patient on the chest, the weight of the body forces the air out; when turned on the side, this pressure is removed, and air enters the chest.]

2.—*Expiration.*

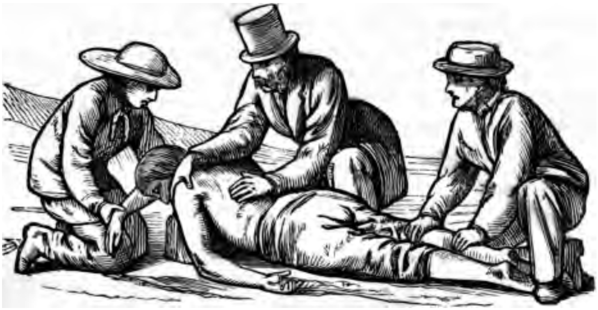

Fig. 31.

[The foregoing two Illustrations shew the position of the Body during the employment of Dr. Marshall Hall's Method of Inducing Respiration.]

On each occasion that the body is replaced on the face, make uniform but efficient pressure with brisk movement on the back between and below the shoulder-blades or bones on each side, removing the pressure immediately before turning the body on the side.

During the whole of the operations let one person attend solely to the movements of the head and of the arm placed under it.

[The first measure increases the expiration—the second commences inspiration.]

⁂ The Result is *Respiration* or *Natural Breathing;*—and, if not too late, *Life.*

Whilst the above operations are being proceeded with, dry the hands and feet, and as soon as dry clothing or blankets can be procured, strip the body, and cover or gradually re-clothe it, but taking care not to interfere with the efforts to restore breathing.

III.

Should these efforts not prove successful in the course of from two to five minutes, proceed to imitate breathing by Dr. Silvester's method, as follows:—

Place the patient on the back on a flat surface, inclined a little upwards from the feet; raise and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulder-blades.

Draw forward the patient's tongue, and keep it projecting beyond the lips: an elastic band over the tongue and under the chin will answer this purpose, or a piece of string or tape may be tied round them, or by raising the lower jaw, the teeth may be made to retain the tongue in that position.

1.—*Inspiration.*

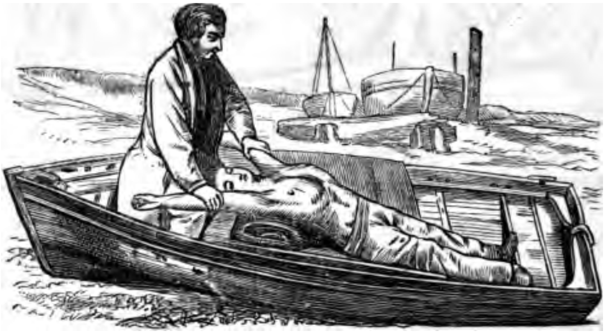

Fig. 32.

To Imitate the Movements of Breathing.—Standing at the patient's head, grasp the arms just above the elbows, and draw the arms gently and steadily upwards above the head, and *keep them stretched* upwards for two seconds. (*By this means air is drawn into the lungs*). Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides of the chest. (*By this means air is pressed out of the lungs.*)

Repeat these measures alternately, deliberately, and perseveringly, about fifteen times in a minute, until a spontaneous effort to perspire is perceived, immediately upon which cease to imitate the movements of breathing, and proceed to INDUCE CIRCULATION AND WARMTH.

2.—*Expiration.*

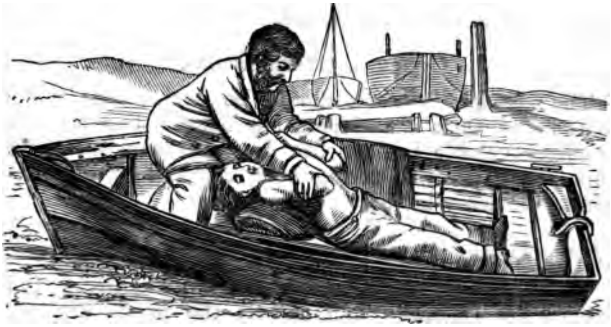

Fig. 33.

[The foregoing two illustrations shew the position of the body during the employment of Dr. Silvester's Method of inducing Respiration.]

IV.—TREATMENT AFTER NATURAL BREATHING HAS BEEN RESTORED.

TO PROMOTE WARMTH AND CIRCULATION.—Commence rubbing the limbs upwards, with firm grasping pressure and energy, using handkerchiefs, flannels, &c. *By this measure the blood is propelled along the veins towards the heart.*

The friction must be continued under the blanket or over the dry clothing.

Promote the warmth of the body by the application of hot flannels, bottles, or bladders of hot water, heated bricks, &c., to the pit of the stomach, the arm-pits, between the thighs, and to the soles of the feet.

If the patient has been carried to a house after respiration has been restored, be careful to let the air play freely about the room.

On the restoration of life, a teaspoonful of warm water should be given; and then, if the power of swallowing has returned, small quantities of wine, warm brandy and water, or coffee should be administered. The patient should be kept in bed, and a disposition to sleep encouraged.

GENERAL OBSERVATIONS.

The above treatment should be persevered in for some hours, as it is an erroneous opinion that persons are irrecoverable because life does not soon make its appearance, persons having been restored after persevering for many hours.

APPEARANCES WHICH GENERALLY ACCOMPANY DEATH.

Breathing and the heart's action cease entirely; the eyelids are generally half closed; the pupils dilated; the tongue approaches to the under edges of the lips, and these, as well as the nostrils, are covered with a frothy mucus. Coldness and pallor of the surface increase.

CAUTIONS.

Prevent unnecessary crowding of persons round the body, especially if in an apartment.

Avoid rough usage, and do not allow the body to remain on the back unless the tongue is secured.

Under no circumstances hold the body up by the feet.

On no account place the body in a warm bath unless under medical direction, and even then it should only be employed as a momentary excitant.

SUGGESTIONS IN CASES OF FIRE.

DIRECTIONS TO INMATES.

THE inmates of a house in time of safety should make themselves acquainted with the best means of escape, whether the fire breaks out at the top or bottom. On the first alarm of fire they should reflect calmly what means there are of extinguishing it, and the best means of escape. If in bed at the time they should not wait to dress, but wrap themselves in a blanket or bedside carpet, open no windows or doors unnecessarily, *and shut every door after them.*

There is always comparatively a clear space of about twelve inches between the floor and the smoke; consequently, a room full of smoke can be entered on the hands and knees, and, by applying a wet silk handkerchief, a wet worsted stocking, a wet sponge, or any wet flannel substance folded over the nose and mouth, free breathing may be obtained even in the midst of smoke.

In the event of being unable to escape by either the roof or street door, all persons in danger should at once make their way to a front room window, taking *care to close the door after them.* The head of the establishment should then ascertain that every individual is there assembled. Should no means of escape be procured from without, a rope, or blankets and sheets joined together, with one end fastened to the bars of the grate or a heavy piece of furniture, will enable one person to lower all the others separately, and at last let himself down with very little risk.

Should no rope or other means for lowering the household be at hand, *all persons are strongly entreated not to throw themselves out of the window,* but to wait till the fire is close upon them, as assistance may come at any moment.

A fire may often be kept well under, and frequently completely extinguished, by means of a hand-pump, *provided doors and windows are kept closed to prevent a draught.* It is strongly recommended that all public institutions and large private houses should have one or more of these useful little engines always kept in some convenient place, which should be accessible from as many directions as possible.

DIRECTIONS TO BYSTANDERS.

Immediately on a fire being discovered, see that notice is given *at once* to the Police and the Fire Brigade Station. Ladders and ropes should be sought for. Assistance can also often be rendered by an entrance being made from the roof of an adjoining house to the upper part of the house on fire, either by the attic windows or by removing the slates.

When no other means present themselves, the bystanders had better collect bedding at hand in case the inmates throw themselves from the windows. A blanket, a carpet, or even a policeman's greatcoat held out by several persons breast high, will serve the purpose of a jumping-sheet.

Bystanders should never give vent to the fire by breaking into the house unnecessarily from without; but in the event of anyone entering the house, a strong point should be made of shutting every door after him *as he goes through the house.*

ACCIDENTS TO THE PERSON.

Upon discovering yourself to be on fire, reflect that your greatest danger arises from draught to the flames, and from their rising upwards; throw yourself on the ground, and roll on the flames, drag the hearth-rug round you, or anything that is nearest and will serve your purpose. Scream for assistance—ring the bell—but do not run out of the room, or remain in an upright position.

HOME EXERCISES.

SIXTH BOOK.

ROBERT AND WILLIAM CHAMBERS—(PAGE 9).

Peebles—an ancient town in Scotland (on the Tweed), 22 miles from Edinburgh; from its beautiful situation in a hunting country it became an occasional residence of the kings of Scotland; the name signifies "dwelling-places."

Immemorial (Latin, *in*, not; *memor*, mindful of)—beyond the memory of man.

Woollen manufacturers–the makers of woollen cloth, a trade introduced into England by Eleanor, wife of Edward I., who imported Spanish sheep from her native country, Castile; this was followed by Philippa, Queen of Edward III., who brought Flemish workmen from her native country to instruct the people in dyeing and manufacturing wool; they were settled at Worsted, a village in Norfolk, A.D. 1331, from which place woollen yarn has taken its name.

Substantial—prosperous and rich.

Cotton-spinner—one who converts cotton wool into yarn, by twisting it with a spinning wheel; this was formerly done by hand, but now by machinery, the first "spinning jenny" being invented about 1767 by James Hargreaves, a Lancashire weaver.

Looms—machines for weaving yarn into cloth; at first worked by hand, but now by machinery (see p. 83).

Buts and bens—"but" the outer, and "ben" the inner apartment of a Scotch cottage, consisting only of two rooms; the words are shortened from "be-out" and "be-in."

Box-bed—a shut-up bedstead, looking like a box or chest of drawers by day.

Power-looms—looms worked by steam power.

Revolutionized—effected a complete change in the trade.

Grammar School—a school in which the Latin and Greek grammars are taught; most of those in England were founded by Edward VI. and Elizabeth, and endowed with money taken from the monasteries, so as to supply a free and good education to boys, whose parents were not able to defray the cost.

Harried—stripped.

Spartans—the inhabitants of Sparta, the ancient capital of the Morea of Greece, celebrated for the strict way in which its inhabitants were brought up by law, from childhood, to bravely endure the most severe pain and hardships; so it means brave, hardy, self-denying.

Encyclopædia—(properly, *a circle of instruction*) generally used for a collection of the principal facts, principles, and discoveries in science and art, arranged alphabetically under proper titles.

Competitive examination—a trial by examination of the respective qualifications of candidates for an office.

Muscular powers—the powers of strength of muscle.

Academy — originally a garden, grove, or shady walk, near Athens, where Plato instructed his pupils in philosophy; now it means either a school between a college and a common school, or a society of men (as the Royal Academy) for promoting the study of some art or science.

Pecuniary subsidy—assistance in money, in addition to one's earnings.

Lottery—a game of hazard, in which small sums are risked for the chance of gaining larger ones; certain tickets are bought, to some of which prizes are attached, and to the others blanks; they are all thrown into a vessel or cylinder, shaken up, and then drawn by chance, those getting the prizes who draw the number to which the prizes are attached, the rest losing their money; they were used by many European governments as a means of obtaining money, so called *state lotteries;* but were entirely abolished in this country A.D. 1823.

Tholes (a Scotch word)—bears; endures; strives against difficulties.

Aye to haud forrit—always to press forward.

Comport (Latin, *con*, together; *porto*, to carry)—agree with, suit, accord.

Contraband (Latin, *contra*, against; and French, *ban*, proclamation)—goods forbidden to be exported or imported; or such as are brought in without having paid the necessary duty.

Antiquarian — belonging to the study of ancient times and things, as statues, coins, paintings, books, &c.

Topographical — belonging to the study of the position and history of particular places, cities, towns, castles, &c.

Remainders—books left on hand when the demand for them had ceased.

Eked out—increased; enlarged; supplied what was wanted.

Her seaport—Leith.

Fount of types (or font)—a complete assortment of printing types of one size, including a due proportion of all the letters in the alphabet (both large and small), points, and accents, commonly consisting of 100,000; it is so called from the types being cast or *founded.*

Kaleidoscope—a toy formed of a cylinder of tin with a glass at the bottom and a hole at the top, through which the eye looks towards the light, and a variety of beautiful colours and forms are seen by the reflection of small pieces of glass placed inside it — these forms and colours being varied by each turn of the instrument; its name signifies "beautiful appearance."

Mediæval (Latin, *medium*, middle; *ævum*, age) — the middle age, referring to the transition of the human race from the savage to the civilized state.

Tradition (Latin, *trado*, to deliver)—the handing down from one generation to another of opinions, practices, or history.

Manuscript (Latin, *manu*, by the hand; *scriptum*, written) a book written by the hand or pen, not printed.

Literary world—learned men; persons interested in literature and publications.

Compiled (Latin, *con*, together; *pilo*, to drive)—driven together or made thick; collected from various books and put together.

Pedestrian (Latin, *pede*, on foot)—made on foot or by walking.

Rigorous economy—a strictly frugal expenditure of money.

Geology—the science which treats of the structure and composition of the earth.

Scientific—belonging to the higher branches of knowledge, *e. g.*, philosophy, physics, mathematics, &c.

QUESTIONS.—Where were the brothers born? Describe Peebles. Give the character of their father and mother. How and where were the boys educated? What made them go to Edinburgh? How did they begin business? Describe the way they got on at first. What was the first book they published, and what the first periodical? What first brought them into notice What great author helped them? What books did *he* write? What was their most successful publication? What caused Robert's death? Explain "encyclopædia"—"academy"—"lottery"—"contraband"—"kaleidoscope"—"mediæval"—"Spartan mother."

PLEASURE ARISING FROM VICISSITUDE—(PAGE 21).

Dew-bespangled—dotted or sprinkled with dew, so as to cause a sparkling appearance.

Wintry trance—a state of sleep or unconsciousness during the winter.

Ecstacy—excessive joy or rapture that absorbs the mind.

Lyric—poetry composed to be sung to the harp or lyre.

Vernal (Latin, *ver*, spring)—spring-like, or belonging to spring.

Crystalline—like crystal; pure, clear, transparent.

Madding—raging, furious.

Hebè—the fabled cup-bearer of Jupiter.

Phantom—a ghost, spectre, or apparition.

Spleen—the milt, a spongy substance between the eleventh and twelfth ribs, of an oval form, supposed by the ancients to be the seat of anger, melancholy, or vexation; so, often used for "spite" or "ill-humour."

Scorpion—a kind of insect with a long body terminating in a slender tail, formed in six joints, and containing a very sharp sting, which sends out a poisonous liquid; this sting causes very great pain. Scorpions are found in the south of Europe, Africa, East Indies, South America. Used here for "malicious and spiteful."

Hies him home—runs home quickly; with haste or diligence.

Vicissitude (Latin, *vicissim*, by turns)—change, revolution, or turn of fortune.

QUESTIONS.—What is the description of spring? How does "nature lead the song"? What difference is marked here between man and beast? How is the sick man affected by spring? What is the description of indolence and pride? How is the peasant happier than the ambitious man? Explain "ecstacy"—"lyric"—"vernal"—"Hebe"—"penury."

JAVANESE—(PAGE 24).

Java—one of the Sunda Islands, to the south of India, and east of Sumatra.

Sacrilege (Latin, *sacer*, sacred; and *lego*, to take)—stealing that which is sacred, or appropriating it to any common purpose.

Era (Latin, *æra*, time)—a fixed point of time, from which years are counted, as the "Christian Era."

Praise-giving—a service composed of praises or hymns.

Betel—a kind of pepper; a climbing plant like the ivy, the leaves of which are chewed by the East Indians after meals. During a visit it is offered to friends, when they meet and when they separate. It bears a nut called *areca* (like a nutmeg), which is eaten both in its ripe and unripe state.

Bamboo—a kind of reed, grown in the East Indies and other warm climates, sometimes to the height of 60 feet, having a round jointed stock, which, at 10 or 12 feet from the ground, sends out branches. Cottages are almost wholly made of it; and also bridges, boats, baskets, mats, paper, masts, water pipes, &c.

Justa (Latin, *justum*, right)—rights; deserts; what is merited.

QUESTIONS.—Where do the Javanese live? Describe their villages, and their religion. What ceremonies are observed at their funerals?

BATTLE OF PHARSALIA—(PAGE 26).

Julius Cæsar—a successful Roman general, who obtained supreme power owing to his conquests, and would have been made emperor, had not some patriots formed a conspiracy and stabbed him in the Senate House. The battle of Pharsalia (a plain in Macedonia) was fought between him and Pompey (the successful general of another large Roman army), who was his rival.

Decamped—broke up the camp, and removed to another place.

Struck—tents are said to be *struck* when they are taken down and folded up ready for removal.

Entrenchments—properly the trenches or ditches only; but, as the earth thrown out of a trench forms a bank which is a useful part of a fortification, it generally includes ditches and banks, and sometimes artificial barricades erected on the top of the banks, placed round an army encamped in the field, to serve as a defence.

Javelin (Latin, *jacio*, to throw)—a spear 5½ feet long, with a point of steel, intended to be thrown as a dart, used both by cavalry and infantry.

Cohort (Latin, *cohors*, a band)—a body of infantry composed of 500 to 600 men. Ten cohorts made a legion.

Re-inforcement—additional troops to increase the strength of an army, or to supply the place of those killed.

The flank—the side of an army, or any division of an army. To attack an army upon the flank is to attack it upon the side.

The strangers—those allies of the Romans who were not Romans —*i. e.*, foreigners.

Quarter—sparing the life of an enemy or captive when no longer able to defend himself. It takes its name from an agreement formerly made between the Dutch and Spanish, that the ransom of a soldier should be the *quarter* of his pay.

Auxiliaries (Latin, *auxilium*, help) —allies, or additional troops to render assistance to the main body.

Thracians — the inhabitants of Thrace, a country in Greece, north of the Archipelago.

Barbarians (Latin, *barbarus*, a foreigner)—properly those who speak a different language; generally men in a rude, savage state. Here it means those who were not Romans.

JULIUS CÆSAR—(PAGE 29).

Brutus—a Roman senator, one of the chief conspirators who murdered Julius Cæsar.

Marc Antony—a Roman senator, who remained faithful to Julius Cæsar.

Enrolled—inserted in a roll or register; recorded.

Capitol—a strong tower or fortress on the summit of the Capitoline Hill at Rome, where the Senate met.

Exterminated (Latin, *ex*, out of; *termino*, to make thin)—made smaller, diminished, lessened.

The same dagger for myself—Brutus stabbed himself, when defeated at the battle of Philippi, in Macedonia.

Statue—a full length figure of himself, as a memorial of his service to the state.

Cæsar—put for *emperor*. The first twelve emperors of Rome were all called Cæsars, and the name has been continued to the present day. The Emperor of Austria, having succeeded to the Roman crown, is still called Czar (a corruption of Cæsar).

Honourable—a nobleman, or man of high distinction.

The general coffers—the public treasury.

Cassius—a senator, one of the conspirators.

I have o'ershot myself—gone too far; spoken too plainly.

Nervii—a hardy race of Belgians, twice conquered in battle by Cæsar (B.C. 57 and 54), and almost entirely destroyed.

Rent—a tear or hole.

Casca—one of the conspirators.

Angel—faithful adviser; confidential friend.

Burst his mighty heart—when Cæsar saw Brutus stab him, he gave up all hope, and reproached him for his ingratitude with the expression, "And thou, too, Brutus!"

All the while ran blood—it is said that the marble statue of Pompey miraculously shed blood from the places where Pompey was wounded, as a warning to Cæsar of his own death, and a reproach for having caused Pompey's death.

Gracious (Latin, *gratus*, pleasing)—becoming favourable; acceptable.

Vesture—cloak or mantle.

Orator (Latin, *orŏ*, to pray)—a public speaker, who pleads for himself or another.

Right on—straight forward.

QUESTIONS.—Who was Julius Cæsar? What great battle gave him supreme power? Where was it fought? Explain "javelin"—"entrenchments"—"cohort"—"quarter"—"barbarians." What was the end of Cæsar? Who conspired against him? Whose stab grieved him most? Why? Describe Antony's oration over his body. What was its effect on the people?

SUMATRANS—(PAGE 34).

Sumatra—the largest of the Sunda Islands, south of India.

Paganism (Latin, *pagus*, a village)—heathenism; the worship of false gods and images. It is used of all persons who profess any religion not Christian, because Christianity was first taught and received in cities, while the inhabitants of country villages remained heathen. Heathen signifies, for the same reason, *an inhabitant of the heath* or common, as *Caffre* means one who lives in a hut or cottage, and was first used by Mahommedans of those rural tribes of Africa who did not receive the Mahommedan religion.

Fragmentary (Latin, *frango*, to

break)—composed of small portions or fragments.

Inaccessible (Latin, *in*, not; *accedo*, to approach)—not to be approached or reached.

Inconsiderable—unworthy of consideration or notice.

Unimportant—small; of no consequence.

Cannibals—men who eat human flesh.

Lettered—educated; instructed in learning.

Capital crimes (Latin, *caput*, a head)—crimes punished by the loss of the head, or by death.

Inveterate (Latin, *in; vetus*, old)—very old; long established; deep rooted.

Diabolical (Latin, *diabolus*, the devil)—very malicious, impious, atrocious.

Accessory (Latin, *accedo*, to approach)—one who comes to help another; an assistant; generally used in a bad sense.

THE WATERFALL AT PUPPANASSUM—(PAGE 37).

Carnatic—the most south-easterly province of India.

Genuflexions (Latin, *genu*, knee; *flecto*, to bend)—bending of the knee, or bowing.

Prostrations (Latin, *pro*, forward; *sterno*, to lay flat)—throwing the body forward flat on the face; the act of falling down in adoration.

Besotted—stupified, infatuated, made insensible.

Votaries (Latin, *votum*, a prayer, or vow)—those devoted, consecrated, or engaged by a vow to some particular service, worship, or state of life.

Cataract—waterfall, cascade; a great fall of water over a precipice.

Precipitated (Latin, *præceps*, headlong)—thrown headlong, or hastily, from a height.

Monsoons—a term given to certain disturbances of the regular course of the "Trade Winds" (see *Fifth Book*., p. 191), which takes place in the Arabian and Indian Seas. The eastern Trade Wind blows regularly, but from 10° to 30° north latitude the course is reversed for half the year, the wind blowing constantly from the south-west,—this change is called the Monsoon, and does not take place all at once; but sometimes is attended with calms, sometimes with variable winds, and in others (as in China) with tempests.

Vortex (Latin, *verto*, to turn)—a whirlpool, or circular motion of water, leaving a cavity in the centre; a whirlwind, or a whirling motion of the air.

QUESTIONS.—Who are the Sumatrans, and what is their religion? What is the derivation of "pagan" and "heathen"? Describe the Battas. In what way are they cannibals?

Where is Puppanassum? What wonder is to be seen there? Describe it. How is it regarded by the Indians?

TAKING OF TROY—(PAGE 38).

Troy—an ancient city near the Dardanelles, on the east of the Archipelago. It was besieged by the allied forces of Grecian kings for ten years, at the end of which it was taken by stratagem—the Greeks sailing away as if they had given it up, and leaving behind as a monument an enormous wooden horse, which the Trojans were induced by a Greek deserter to bring into their city. This horse was filled with armed soldiers, who were let out at midnight by the Greek deserter; they set fire to the city, and opened the gates, when the Greek armies returned, and killed the inhabitants.

Hector—the eldest son of Priam, the king of Troy, a most valiant man of gigantic power, who was killed by Achilles during the siege.

Ucalegon—put for the "House of Ucalegon."

Clangors—the blasts of trumpets.

Last extremes—the last chances.

Unequal combat—a contest, in which one party is much stronger than the other.

Imperial city—the chief city of an empire, or the residence of a king.

Plaints—put for *complaints.*

Grisly—pale, gray-haired, grim.

Hews apace—cuts, or hacks with a hatchet, as fast as he can.

Halls of audience—halls in which the king receives deputations.

Hall of public state—the senate or parliament house.

Where . . . in secret sat—a private apartment or boudoir of the queen.

Matrons (Latin, *mater*, mother)—middle-aged women, mothers of families.

Inevitable (Latin, *in*, not; *vito*, avoid)—that cannot be avoided.

Invests (Latin, *investio*, to clothe)—clothes, or puts on; envelops himself.

Uncovered but by heaven—out in the open air.

Doddered—overgrown with dodder—a kind of weed, almost without leaves, that climbs up other plants like withy-wind.

Hecuba—the wife of Priam, queen of Troy, mother of Hector.

Images—the statues of heathen gods.

Æneas—one of the Trojan heroes, who escaped from Troy, and is said to have been the ancestor of the Romans.

Creüsa—the wife of Æneas.

Iülus—the son of Æneas, from whom the Julian family at Rome came.

Anchises—the father of Æneas.

Versed in omen—skilled in foretelling the future from signs in the heavens, or other unnatural events.

Request preferred—offered up a prayer.

Presage (Latin, *pre*, before; *sagio*, to perceive)—a foreboding presentiment; something which foreshows a future event.

Idæan grove—the wood on the mountains of Ida, behind Troy.

Questions.—Where was Troy, and by whom and how destroyed? Describe the burning of the city. Who encouraged the people to defend themselves? Why did it not succeed? Describe the bursting into the palace. What made Æneas cease fighting? What was the flame on his son's head supposed to be? Who were each of the principal persons mentioned?

GARDENING—(Page 43).

Exótic—a plant, shrub, or tree, not a native, but imported from some other country.

Indígenous (Latin, *indigena*, a native)—produced naturally in a country; native.

Tendrils (Latin, *teneo*, to hold)—spiral shoots of a plant which twist round another body for the purpose of support. They are only found in plants whose stem is too weak to keep them erect, as the vine, ivy, &c.

Eradicated (Latin, *e*, out of; *radix*, root)—pulled out by the roots, and so entirely got rid of.

WORD LESSONS.

Page 9.

Immemorial — beyond memory, time out of mind, generations back.
Substantial—well-to-do, wealthy, rich, prosperous.
Original — quaint, old-fashioned, peculiar.

Page 10.

Heroine—the chief female character in a tale; wonderful and devoted person.
Estimable — excellent, valuable, worthy.
Pliancy — flexibility, easiness, amiability.
Fortitude — firmness, courage, steadfastness.
Lucrative (Latin, *lucrum*, gain)—profitable, paying, remunerative.
Unjustifiable—unwarrantable, unpardonable, extravagant.

Page 12.

Consolation — comfort, solace, relief, recreation.
Negotiation (Latin, *negotium*)—bargaining, contract, business.

Page 13.

Despondency — despair, gloom, mistrust.
Achievement — accomplishment, feat, triumph.
Subsidy—help, assistance, addition.

Page 14.

Literary—studious, bookish, scholarlike.
Noxious—hurtful, poisonous, disagreeable, unwholesome.
Admonitory—warning, cautionary, advising.

Page 15.

Devices — plans, contrivances, schemes.
Recognized — acknowledged, *accredited*, admitted, considered.

Page 17.

Traditions — legends, tales, chronicles.
Metropolis—capital, chief city.
Mercantile—commercial, trading.

Page 18.

Reminiscences — memorials, remembrances.
Sequel (Latin, *sequens*, following)—appendix, supplement.
Confided—trusted, entrusted.
Compiled — put together, collected.
Pedestrian—walking, tramping.
Economy — frugality, cheapness, carefulness.

Page 19.

Prospectus—notice, plan, scheme.
Humorous — funny, laughable, amusing.

Page 21.

Trance—sleep, reverie, torpor.
Ecstacy—joy, delight, transport.
Lyre—harp, musical instrument, guitar.
Transport — joy, enchantment, pleasure.
Vernal—springlike, green, fresh, lively.
Harmony—concord, music, song.

Page 22.

Lower—droop, dip, oppress.
Chastised — chastened, checked, controlled, dimmed.
Crystalline—glassy, bright, transparent.

Page 23.

Phantom—ghost, spectre, apparition.
Spleen—spite, malice, revenge.
Scorpion — stinging, poisonous, venomous.
Penury—poverty, scantiness, privation.
Vicissitudes—change of fortune, reverse.

Page 25.

Bamboo—cane, reed, matting.
Contact—touch, union.

Page 27.

Decamp—break up a camp, take one's self off.
Entrenchments—fortifications, defences.

Page 28.

Impetuosity—rushing, eagerness, haste.
Javelins—spears, darts, lampoons.
Visages—faces, countenances.
Intimidate — frighten, affright, terrify, deter.

Page 29.

Clemency—mildness, mercy, pitifulness.
Auxiliaries—allies, friends, helpers.
Remit (Latin, *re*, back; *mitto*, send)—give up, let off payment, forgive.

Page 30.

Ambitious — eager to rise, presumptuous.
Extenuated—diminished, deteriorated, lessened.

Page 32.

Testament—will, document.
Inflame—fire, rouse, excite.

Page 33.

Rent—hole, tear, breach.
Gracious—pleasing, beloved, dear.
Vesture—garment, cloak, robe.

Page 34.

Orator — speaker, pleader, advocate.
Paganism—heathenism, infidelity.
Inaccessible—unapproachable, insurmountable.
Fragmentary—broken, scattered, dispersed.

Page 35.

Inconsiderable—few, small, unworthy of mention.
Lettered — educated, learned, studious.
Inveterate—old, implacable, deep-rooted.

Page 36.

Delinquent — culprit, offender, guilty person.
Depravity — wickedness, crime, degradation.

Page 37.

Besotted—infatuated, stupefied, dulled, insensible.
Placid—gentle, calm, serene.
Votaries—devotees, worshippers, disciples.

Page 38.

Cataract—cascade, waterfall.
Monsoons—tempests, trade-winds.

Page 39.

Undistinguished—confused, mingled.
Clamour—shout, din, noise.
Involved — wrapt, enveloped, smothered.

Page 40.

Whelps—young, cubs, puppies, offspring.
Extremes—extremities, chances.
Plaints—complaints, cries, wailings.
Grisly—grim, horrible, fierce.
Vaulted—arched, domed, rounded, canopied.

Page 41.

Inhuman—brutal, savage, cruel.
Dams—banks, mounds, sluices.
Inevitable—destined, unavoidable.
Loaded — weighted, overborne, oppressed.

Page 42.

Destiny—fate, chance, luck.
Diverted—turned aside, distracted, interrupted.
Lambent — flickering, shining, waving.
Slake—lave, deluge, soak, souse.
Streaming lamp—meteor, shooting star, comet.

Page 43.

Drills—trenches, nicks, furrows.

SCENE FROM "ROMEO AND JULIET"—(PAGE 47).

Agate stone — semi-transparent gems of many varieties, found in rocks in the form of fragments or small round lumps, variegated with dots, figures, and patterns resembling moss.

Atomies — used for very small atoms; particles of matter too small to be divided.

Film—a thin skin.

Tithe-pig—the tenth of a litter of pigs, formerly due (like the tenth part of all other produce) for the support of the clergy.

Benefice (Latin, *beneficium*, a gift) —generally used for a church living, as a rectory or vicarage.

Spanish blades — the swords of Spaniards; Toledo, in Spain, being celebrated for the manufacture of sword blades.

Healths five fathom deep—deep cups of ale or wine for drinking a person's health.

Elf-locks—knots of hair supposed to have been twisted by elves (fairies).

Foul, sluttish hair—the hair of a slovenly woman grown dirty or matted for want of combing.

QUESTIONS.—What is the good of *digging* land? How can garden plants be classed? What is the object of tillage? Give some general rules for gardening. When is artificial heat required? How is it applied? How are young plants *planted out*, and how treated afterwards? What plants will not bear deep digging between the rows? Why? Why are celery and sea kale covered up?

Who is meant by "Queen Mab"? How does she ride about? Tell some of the dreams she puts into people's minds.

GARDEN VEGETABLES—(PAGE 49).

Botanical characters — the class under which they are placed by botanists (those who study the science of the structure of plants).

Condiments (Latin, *condio*, to season)—sauces or seasoning to give a relish to meat, or to please the taste.

Cereālia (Latin, *Ceres*, the goddess of corn)—all grains which are fit for eating.

Leguminous—plants which have their fruits in pods, as peas and beans.

Farína (Latin, *farina*, meal)—meal or flour; a term given to the glutinous part of wheat or other seeds, obtained by grinding and sifting it. It consists of gluten and starch.

Fragrance (Latin, *fragro*, to smell strong) — sweetness of smell; pleasing scent.

Ervum—an order of plants of the lentil genus, to be found abundantly in all parts of Europe.

Deleterious (Latin, *deleo*, to destroy)—destructive, poisonous, injurious.

VEGETABLE PRODUCTIONS—(PAGE 51).

Théă—a genus of plants which include the species yielding tea, of which there are only three at the most, viz., *green*, *Bohea* and *Assamica*. The first is a large, hardy, evergreen plant, with light-green, wavy, broad leaves, from 3 to 5 inches long, found in China and Japan. *Bohea* is a smaller plant, and different in several particulars. "Bohea" is a corruption of "Duhee," the name of the hills on which it is grown; for a similar reason, another kind is called *Twankay*—*i.e.*, "Beacon Brook." Other names denote the kind of leaf, as Souchong, "little sprouts," *Pekoe*, "white down;" or the time of gathering them, &c., as *Hyson*, "fair spring," *Young Hyson* (Yutseen), "before the rains," *Congou*, "labour." The growth of tea plants is principally confined to hilly tracts unsuitable for corn.

Coffee—the berry of a plant, called coffëä, a native of Caffa, in Arabia, but now cultivated in the southern extremity of India, Java, West Indies, and Brazil. The fruit grows in clusters along the branches, under the leaves. Each berry contains two seeds.

Peruvian bark—the bark of several species of a tree grown in Peru, from which is made a valuable tonic called quinine, which is bitter to the taste, and binding in its effects.

Ip-e-ca-cu-an-ha—the root of several plants, growing in South America, of a disagreeable smell and bitter taste; used as an emetic to cause vomiting.

Cacáo—the chocolate tree, a native of the West Indies, bearing oval and pointed pods, containing numerous seeds lodged in a white substance.

Questions.—What parts of a plant are chiefly eaten? From what do we make flour? What are leguminous plants, and which of them do we use most? Which are eaten by cattle? Which are poisonous? What part of a potato is poisonous? What plants are used for making hot drinks? Where do they grow? Describe the various kinds of tea. Which is the best? What is the nutritive part of tea, and what is its benefit? Explain the various names by which teas are called?

KING RICHARD III.—(Page 53).

Clarence—the Duke of Clarence, brother of Edward IV. and Richard III., who was drowned in a butt of wine (see *H. E.*, *Book V.*, p. 303).

Tower—the Tower of London, built on the Thames by William I.

Gloster—the Duke of Gloucester, afterwards Richard III.

Hatches—the grate or frame of cross bars laid across the opening in a ship's deck. A lid or cover for such opening is now called a hatch.

Inestimable—too precious to be valued; invaluable.

Sour ferryman—Charon, said by ancient poets to convey the souls of the dead, in a boat, across the stream that separated this world from the next.

Warwick—Richard Neville, Earl of Warwick, the king-maker (see *H. E.*, *Book V.*, p. 303), whose daughter married the Duke of Clarence.

This dark monarchy—the kingdom beyond the grave.

A shadow like an angel—the spirit of Prince Edward, son of Henry VI. (see *H. E.*, *Book V.*, p. 303), killed by Clarence after the battle of Tewkesbury.

Questions.—Who was Richard III.? When did he come to the throne? Where and when was he killed? How did he get the crown? Who was Clarence? What was his dream? Who did he see in the next world? How was it fulfilled? Write a short account of Richard Neville.

SOAP—(Page 55).

Potash—the popular name of vegetable alkali in its impure state, procured from the ashes of plants; when refined by heat it is called *pearl ash*, or impure carbonate of potash.

wormwood yields the greatest quantity.

Resin—a solid inflammable substance, that cannot be dissolved in water, but only in alcohol and essential oils; it is brittle and transparent; it is a non-conductor of electricity, and when rubbed its electricity is negative; it is heavier than water, and will melt by heat. It flows from trees in a semi-liquid state, in combination with essential oils, from which it is supposed to be formed; when mixed with turpentine or alcohol, it makes a fine varnish.

Turpentine—an oily resinous substance flowing from several species of trees, as the pine, birch, and fir; it is dissolved in pure alcohol; and oil is distilled from it, when it is called spirits of turpentine.

Carbonic acid—a saturated combination of carbon and oxygen. It exists in the atmosphere, and it is the result of decomposition, and is poisonous, and fatal to animal life; being heavier than air, it falls into low places, as wells and vaults.

Palm oil—a fatty substance, obtained from the palm tree, which grows on the west coast of Africa; it is used by the natives there as butter, and, when fresh, it is a wholesome and delicate article of diet.

Oxide of lead—there are four oxides of lead—1st, the suboxide, of a grayish blue colour; 2nd, the protoxide, or yellow oxide; and, 3rd, suboxide, usually called red lead; 4th, the peroxide, made by putting red lead into nitric acid. The protoxide is the base of the salts of lead, and is employed for glazing earthenware and porcelain; the carbonate or white lead is most important in paints. All are poisonous, but white lead is by far the most virulent. England produces the largest quantity of lead—its produce being estimated at 50,000 tons per year.

Organic acids—those which are formed from animal or vegetable matter.

Glycerine—the sweet principle of oils and fats.

LEATHER—(PAGE 57).

Gall-nuts, or nut galls—a hard round substance produced by a small insect which deposits its eggs in the tender shoots of an oak, abundant in Asia Minor, Persia, &c. When the maggot is hatched from these eggs, it produces nut galls, varying in size from a pea to a nut; they are white, green, and blue, the two latter being the best. Their chief products are tannin and gallic acid; they are used in dyeing and making ink, and are chiefly imported from Aleppo, Smyrna, Tripoli.

Sumach—a genus of evergreen shrubs, and of trees which shed their leaves; found in the south of Europe, Africa, and North and South America. Most of the species are poisonous, and many are used for the purpose of dyeing and tanning.

Astringency—that quality in drugs and plants which binds, contracts, or strengthens parts which are relaxed.

QUESTIONS.—Of what is soap made? Describe the process. What is "Old Brown Windsor"? How are skins made into leather? What is "tanning"? Describe the tanning of skins. How are very thin skins made? How are potash, palm oil, and turpentine obtained? What are the peculiarities and uses of resin? What are gall-nuts, where found, and for what used?

PAPER—(PAGE 59).

Esparto grass—a species of rush found in the southern provinces of Spain; used also for making cords, shoes, baskets, and nets.

Gypsum — sulphate of lime, a mineral which is found in a compact and crystallized state, as alabaster, or in the form of a soft chalky stone, which in a very moderate heat bebecomes a very fine white powder, known as "plaster of Paris;" the latter is found in great masses near Paris, and other parts of Europe.

Chloride of lime—formed by exposing hydrate of lime to chlorine. This united with water is one of the best bleaching agents.

Aniline—an organic base, a product of the action of heat on an acid, in combination with which it forms a salt; the acid is prepared by dissolving indigo in hot potash water, and adding some powdered peroxide, by which means dyes are produced.

Adjustment — regulation; alteration; making to fit as required.

LOOKING GLASSES—(PAGE 63).

Quicksilver — mercury, a metal found, both native and in a state of ore, in mines, and so fusible as to be only frozen at four degrees of cold below zero; it is the heaviest metal next to gold and platinum.

Tin-foil—tin beaten out to a thin leaf.

Amalgamate—to compound quicksilver with another metal.

Superfluous (Latin, *super*, over; *fluo*, to flow)—that which overflows, or is beyond what is necessary.

Metallic amalgam—a compound of quicksilver with some other substance in a liquid state.

QUESTIONS.—From what is paper made? What is used for bleaching it, and giving it colour? Describe the process of paper-making? How is the water-mark made? How long could a sheet be made? How are sheets cut? What is the sizing machine? What are "Esparto grass"—"gypsum"—"chloride of lime"—"aniline"—"pulp"? Describe the silvering of looking glasses. What is quicksilver? Why is it used for thermometers? How are glass globes silvered inside?

HENRY V.—(PAGE 64).

Scrupulously—with a nice regard to exact propriety.

That prodigious army—the French army consisted of 150,000, and was ten times as great as the English army.

Agincourt—a plain between St. Omer and Abbeville, about sixteen miles beyond the former.

Omnipotence (Latin, *omnis*, all; *potens*, powerful)—the almighty power of God.

Inly ruminate—silently meditate in their own minds.

Investing—putting on.

Lank-lean—very thin, loose, and wrinkled.

Attaint—stain, spot, slander; anything injurious.

Semblance—appearance, likeness.

Mean and gentle—poor and rich.

Save—except.

Flattery—false praise, called "poisonous," because used for a wrong purpose, and always injurious.

Subtly—cunningly, artfully, slily.

The balm—the oil with which a king is annointed at his coronation.

Sceptre, balls, sword, mace, crown—the insignia of royalty given to a king at his coronation.
Vacant—free from care.
Distressful bread—bread earned by the sweat of the brow.
Vantage—put for "advantage."
The fault my father made—the usurpation of the crown by Henry IV., who dethroned Richard II., and had him murdered.
Richard's body interred anew—Henry V. brought up the body of Richard II. to London, and placed it in a handsome monument, prepared during his lifetime by Richard himself in the Confessor's Chapel at Westminster Abbey; at this second funeral Henry V. followed the body as chief mourner.
Five hundred poor—Henry endowed a chantry at Westminster, a priory for forty monks at Richmond, a convent for sixty nuns at Sion House, "to keep up a constant succession of holy exercises to the end of time," so that when one had finished their devotions the other should instantly begin.

QUESTIONS.—What was the prayer of Henry V. when made king? What great victory did he win, and against what force? What was his conduct and his prayer the night before the battle? What was on his conscience, and what had he done to expiate the crime? What was the act of thanksgiving by the army after victory?

GOLD-LEAF BEATING—(PAGE 67).

Malleable (Latin, *malleus*, a hammer)—able to be drawn out and extended by being beaten out by a hammer,—a quality of metals, particularly of gold.
Vellum (Latin, *vello*, to pluck off the hair)—a fine kind of parchment, made of *calf's* skin, rubbed clear and smooth for writing upon.
Diameter—the measurement across the centre of a circle from one outer edge to the other.
Fatigued—tired, weary.
Adhering (Latin, *ad*, to; *hæreo*, stick)—sticking to.

LADY OF LYONS—(PAGE 70).

Tended—attended to, took care of.
High sphere—lofty station.
Lord—master.
Mean estate—low birth, or low condition.
Glassed—reflected as in a glass.
Sages—wise men.
Poësy—the art of making poetry.
On the painter's canvas grew—was painted, as a portrait.
Exorcise—cast out, expel, drive away.
Enthusiast—a person of ardent zeal; one whose mind is highly excited with the love, or in the pursuit, of an object.
Disdain—scorn, contempt.
Chaos—confusion, disorder, in which one thing cannot be distinguished from another.

QUESTIONS.—What peculiarity has gold? How is it beaten into gold-leaf? What use is made of this? What was the fault in Pauline's character? How was Melnotte her inferior? What annoyed him? How was he spurred to exertion? What base revenge did he take?

INK—(PAGE 72).

Permanent (Latin, *per*, through; *maneo*, to remain)—lasting, enduring, continuing in the same state.

Carbon (Latin, *carbo*, a coal)—pure charcoal, produced from vegetable matter by heat; when crystallized it forms the diamond. It is a conductor of electricity, but a very bad conductor of heat, and will absorb different gases; it is useful for fuel, for converting iron into steel, for making gunpowder, and as the basis of black paint and ink.

Pliny—a Roman philosopher and historian, who was suffocated by the eruption of Vesuvius, which destroyed Pompeii, A.D. 79.

Despicable (Latin, *de*, down; *specio*, to look)—that which deserves to be looked down upon or despised; contemptible or mean.

Papyrus—a plant found in many tropical countries (especially in the valley of the Nile) from the stem of whose soft flower a thin substance was peeled off, and afforded the most ancient material for writing upon, or from which a kind of paper was made.

Parchment—the skin of a *sheep* or *goat* dressed or prepared for writing upon; this is done by separating it from all the flesh and hair, rubbing the skin with pumice stone, and reducing its thickness with a sharp instrument.

Unstable (Latin, *sto*, stand)—that will not stand, not fixed.

Cinnabar—native cinnabar is an ore of quicksilver, very heavy, and of an elegant red colour; it is called native vermilion, chiefly used in printing; red ink is now made of a solution of alum and Brazil wood.

Cavities—the nicks or holes cut in.

Animal glue—glue made from boiling bones or cartilage.

Pamphlet—a small book, consisting of a sheet or a few sheets stitched together, but not bound.

Linseed oil—procured from the seed of lint or flax; it is clear, with a faint, peculiar odour and taste, extensively used for painting and other purposes.

Oxalic acid—the acid of sorrel, found also in the roots of rhubarb, and in several kinds of lichen; it forms the juice commonly called the "salts of lemon," and is very poisonous.

Brazil wood (meaning *a live coal* or a *glowing fire*)—a very heavy wood, of a red colour, growing in tropical countries, and used in manufactures for dyeing red; this name was given to the wood (and so to that country of South America where it is most abundant) by Emmanuel, King of Portugal, on account of its bright colour.

Nitrate of silver—when silver is oxidized and dissolved by nitric acid, and diluted with twice its weight of water, it forms a solution, which yields on cooling transparent crystals called "nitrate of silver;" these are melted at a heat of 420°, and the water driven off, when the nitrate assumes a black colour, and may be moulded into small sticks, which form caustic; it is sometimes used to dye the hair black.

Ammonia—a gas obtained from sal-ammonia, which is produced by burning coal; it is composed of nitrogen and hydrogen, but is not used in the form of gases, but in solution in water, and is then called liquid ammonia; it may be procured naturally from the decomposition of animal substances, especially bones, hoofs, and horns, and also from vegetable matter; artificially it is procured from most animal matter by heating it in iron cylinders.

Mahogany—a tree, growing in the West Indies and Central America, whose trunk is often 40 feet long and 6 feet thick; it is of a reddish or brown colour, is very hard, and takes a fine polish;

it is chiefly imported from Campeachy and Honduras, on the Isthmus of Darien; that which comes from the Islands is called Spanish mahogany.

Nitric acid—a compound of oxygen and nitrogen (5 parts of the former to 1 of the latter); it was formerly called "spirit of nitre," and is prepared by distilling a mixture of sulphuric acid and nitre; when tin is dissolved in it, it becomes the basis of some of the finest dyes.

Muriatic acid—composed of 1 part of hydrogen and 1 of chlorine reduced to a liquid by condensation, when it acts powerfully upon many mineral and animal substances.

Spirit of salts—an old name for hydrochloric acid.

QUESTIONS.—What was the earliest material for writing upon? How was ancient ink made? What coloured inks were then used? From what fish was ink obtained? What four kinds of ink are there now? How is printing ink made? How can you get ink spots out of linen, mahogany, and slate? What are papyrus and parchment, and for what were they used? What are *cinnabar, carbon,* and *Brazil wood,* and for what are they used? Define the four acids described above, and give some of their uses. How are *nitrate of silver* and *ammonia* obtained? Name some of the purposes to which they are applied. From whence do we get mahogany? For what do we use it? Why?

CLEANLINESS OF PLANTS—(PAGE 77).

Waxy secretion—a coating of wax deposited on the surface by a perspiration of the plant.

Dispersive reflection—the throwing back of light or colour in distinct, separate rays.

Problem—a question which appears neither absolutely true nor false, and so admitting an answer either way.

Terrestrial (Latin, *terra*, earth)—belonging to the earth.

Essential (Latin, *esse*, to be)—being; that which is necessary to existence; the first principles or chief points.

Superficial texture—the covering of the surface.

Larvæ—insects in the caterpillar or grub state.

Salubrity (Latin, *salus*, health)—healthiness or wholesomeness.

Secondary—that which is not of the first importance.

Luminous (Latin, *lumen*, light)—shining; sending out a light. The decomposition of fish causes a light from the phosphorus contained in their composition.

Fantastic — fanciful; imaginary; not real.

Balmy—soft; sweet; fragrant.

QUESTIONS.—How are plants and insects kept clean? How do feathers keep birds clean? What similar contrivance have bees and butterflies? What makes dead fish shine? For what purpose? To whom is the Morning Song addressed? What does its light gladden? What is the light wind called, and what is it bidden to do?

SILVER—(PAGE 80).

Determinate—limited, fixed, definite.

Crystallization — the process by which the parts of a solid body, which have been separated by a fluid or heat, unite again and form a solid body.

Arsenic—an acid from which a metal (arsenic proper) may be obtained, by mixing it with half its weight of black flux, and raising it to a red heat. It is of a steel-blue colour, quite brittle, and is a most deadly poison. It readily combines with most metals.

Vitreous (Latin, *vitreus*, glassy)—resembling glass.

Prevalence (Latin, *pre*, before; *valeo*, to be strong)—superior strength, influence, or quantity.

Primitive and secondary earths—those supposed by geologists to have been formed first and second in the crust of the earth.

Hornstone—a flinty stone; a subspecies of quartz; a name given to numerous varieties of rock crystal. It easily scratches glass, and becomes electric by rubbing.

Jasper—a mineral of the same genus as the former, but softer. It is not transparent, but admits of a beautiful polish, and is used for vases and seals.

Königsberg (*King's Town*)—a town in Thelemarken, in the south of Norway.

Native silver—pure silver, found in thin plates, leaves, or fine threads.

Andes—a chain of mountains in Peru, on the north-west coast of South America.

Potosí—the most elevated city in the world, and containing the richest silver mines known.

Volatilized (Latin, *volo*, to fly)—rendered liable to evaporate or float in the air.

Focus (Latin, *focus*, a fire or hearth)—a point where any number of rays of light meet after being reflected or refracted.

Ductile (Latin, *duco*, to lead or draw)—that which may be drawn out or extended by beating.

Tenacity (Latin, *teneo*, to hold)—that quality of bodies which makes them stick or adhere to others; also that property of material bodies which we call toughness, by which their parts resist an effort to force or pull them asunder.

QUESTIONS.—In what various forms is silver found? In what earths is it found? With what minerals is it often combined? In what climates is it chiefly found? Where are the most extensive mines? What are the chief properties of silver? In what is it deficient? What is the most *ductile* and *tenacious* metal? Explain these two words.

HAND-WEAVING—(PAGE 83).

Shuttle—an instrument for passing or *shooting* the thread of the woof in weaving from one side of the cloth to the other, between the thread of the warp; it is shaped like a boat, pointed at both ends, in the middle is a hollow called the "eye" or "chamber," fitted with a spindle, on which is fixed the bobbin of the woof, called the *spoul*.

Magnified (Latin, *magnus*, great; *fio*, to become)—made to appear greater than it is by means of a lens, or glass, which makes it seem larger.

Damask (from Damascus, where it was first made)—a stuff of silk, woollen, or linen, having a pattern upon it raised above the ground, representing flowers and other figures.

Spitalfields—formerly a suburb of London, but now a thickly-populated part of the city, where silk weavers first established themselves.

Fabrics (Latin, *faber*, a workman)—structures of any kind, anything composed of connected parts, but generally used of manufactured cloths.

HENRY VIII.—(PAGE 86).

The Emperor—Charles, King of Spain, who, on the death of Maximilian, was elected Emperor of Rome and of Germany.

Commendations—regards or respects.

His young daughter—the Princess Mary, afterwards queen.

Breeding—bringing up, or education.

Wench—a young woman, formerly used in a favourable, but now generally in an unfavourable sense.

His long trouble—herself.

Embalm—to open a dead body, take out the intestines, and fill their place with spices and drugs, to preserve it from decomposition.

Unqueen'd—deprived of queenly rank, being divorced on the ground of her marriage being illegal.

QUESTIONS.—Who invented weaving? What is its use? Describe the process of separating the threads. What are they called? How is the weft passed through them? Describe the shuttle. How is it now worked? What is used to stiffen the warp?

Who was Henry VIII.? Name his wives. Which wife was Katherine? What was her end? Who was her nephew, the Emperor? Who was her daughter?

THE MANUFACTURE OF GLASS—(PAGE 87).

Invention (Latin, *invenio*, to find out)—the finding out something new, or the contrivance of that which did not before exist.

Discovery—the bringing to light that which existed before, but was not known—*e.g.*, the power of steam.

Pyramids (Greek, *pūr*, fire)—solid bodies, having wide bases and culminating in points, like the flame of a candle. Here the "Pyramids of Egypt" are meant, which are enormous monuments (70 in number), erected partly, as it is supposed, in the time of the Pharaohs, as monuments or tombs of the kings.

Diminutive—very small, little, contracted.

Tyre—a very ancient and important seaport town, the capital of Phœnicia, in Syria, and which was the first great naval power in Europe, till subdued by the Romans.

Saltpetre—a neutral salt, formed by nitric acid combined with potash; it is found native in East Indies, Naples, Spain, &c.

Portland Vase—a celebrated urn or vase now in the British Museum, found at Rome in the tomb of Alexander Severus; it is made of a deep blue glass, with figures upon it of the same material, but whiter.

Political intrigue—a plot or scheme of a complicated nature, intended to effect, by secret arts, some purpose connected with the government.

Taxable article—an article on which duty is paid.

Excise—an inland duty laid on articles of consumption. It was first collected by the Long Parliament in 1643.

Flux (Latin, *fluo*, to flow)—any substance or mixture used to promote the infusion of metals or minerals.

Crucibles—chemical vessels, or melting pots, made of earth, and so baked as to endure extreme heat without melting; they are used for melting ores, metals, &c.; glass-makers' crucibles are made of Stonebridge clay.

Conical—having the form of a cone, round at the bottom and tapering at the top.

Litharge—the yellow protoxide of lead, partially fused.

Fused (Latin, *fundo*, to pour out)—melted, made liquid, reduced to a fluid state by heat.

Damped—cooled down.

Carbonate of lime—a most abundant natural product, found pure in statuary marble, chalk, and several varieties of limestone.

Spectator (Latin, *specto*, to look)—a looker-on.

Annealing—tempering by heat, for the purpose of rendering less brittle; this is done by heating the metal nearly to a fluid state in an oven or furnace, and suffering it to cool gradually.

Protuberance — a swelling or tumor on the surface of anything.

Emery powder—a massive variety of sapphire ground into powder, consisting of very fine grains; its colour varies from a deep gray to a blackish gray; it is necessary for polishing metals and hard stone; it will cut ordinary gems, but not diamonds.

Friction (Latin, *frigo*, to rub)—rubbing the surface of one body against that of another.

Colcoth—the brown red oxide of iron which remains after the acid has been distilled from sulphate of iron.

Bologna—a city in the north of Italy.

Astronomer—one who studies the movements of the planets, and the principles by which they are regulated.

Philosopher—one who studies physics, or moral or intellectual science.

QUESTIONS.—How was glass discovered? Give some instances of its ancient existence. In what country was it first famous? When was the first patent granted in England? Where was the first large manufactory? Of what is it made? Describe the process of glass-blowing. How is window-glass made? What is plate-glass? How is its brittleness counteracted? What is a Bologna Phial?

MANUFACTURE OF HORSE-NAILS—(PAGE 98).

Charcoal iron—iron melted in a furnace heated by charcoal.

Patents (Latin, *pateo*, to lie open)—a privilege from the crown, granted by public letters, conveying to the inventor the sole right to make, use, or dispose of, some new invention or discovery, for a certain limited period (in England 14 years).

Provisional protections—temporary securities granted by the Crown to the inventor against competition in the production of his invention.

Projection (Latin, *pro*, forward; *jacio*, to cast)—a jutting out, or formation of a ridge.

Capital—the sum of money or fund saved up by a manufacturer to pay wages and carry on his trade, until he gets paid for his produce.

Skilled artizans—mechanics, or workmen, who have made themselves masters of their trade.

Sterling—a term applied to English money, signifying that it is of the fixed, or standard national value.

Elongation—a lengthening out.

Lateral collar (Latin, *latus*, a side)—a side, rim, or ridge, raised above the surface.

Contorted (Latin *con*, together; *torqueo*, to twist) — twisted together out of the straight line.

Lubricated (Latin, *lubricus*, slippery)—made smooth or slippery.

Carbonaceous deposit—a skin or film of soot or black varnish.

Prominences—things standing out or jutting from the surface.

Die—a stamp used to give a form to metal by compression, and not by moulding.

Intermittent (Latin, *inter*, between, *mitto*, to send)—at intervals; pausing, and then going on.

Axis—the straight line, real or imaginary, passing through a body on which it revolves.

Horizontal—parallel to the horizon, or on a level.

Spiral (Latin, *spira*, a spire or winding staircase) — winding round a fixed point or centre, like a cork-screw, or a watch-spring.

Fire-waste—that which is wasted or consumed by the action of the fire.

Ingenuity (Latin, *ingenium*, talent) —the quality of ready invention.

Questions.—How are horse-nails generally made? What are the requisite features of a horse-nail? Why was it difficult to make it by machinery? Where were they usually made? How much could a man earn? Who has succeeded in making them by machinery? Describe the process. How many can be made in a day? Explain "horizontal axis"—"die"—"lateral collars"—"lubricate"—"spiral springs."

THE ATMOSPHERE—(Page 103).

Elastic—springing back, having the power of returning to the form from which it is bent.

Densest (Latin, *densus*, thick)—most close, compact, thick.

Limpet—a small shell-fish which sticks to the rocks.

Atmospheric pressure—the weight of the air.

Diving bell—a large, closed vessel, like a bell, lowered into the water to enable persons to go down below the surface, and examine the foundations of bridges, or recover articles from sunken vessels. The air in the bell prevents the water from coming into it, and this air is replenished by a pipe fitted into its roof, and communicating with the air outside.

Glass receiver—a bell-shaped glass with its opening placed upon a table, a pipe from an air-pump being inserted through the table into the mouth, and the air pumped out.

Vibration—the act of moving, or the state of being moved one way and another in quick succession.

Conversed—held conversations, or talked together.

Intercepting (Latin, *inter*, between; *capio*, to take)—catching a thing on its way; standing between one thing and another, so as to stop it from going on.

Evaporation (Latin, *e*, out; *vapor*, steam)—the sending out of a fluid in vapour or steam, which, being lighter than the air, rises upwards.

Respiration (Latin, *spiro*, breathe; *re*, again)—breathing continuously from the lungs.

Questions.—What is the atmosphere? How far does it extend? Name some of its uses. What would be the effect if it were lighter or heavier? How does it cause sound? Prove that it contains moisture. Why does it? How does it get the moisture?

LORD WILLIAM—(Page 107).

Well had conscience calendar'd—his guilty conscience kept an exact record of the day, like a diary.

Quaffed — swallowed in large draughts.

Saps—undermines.

Plied—pulled hard, worked diligently, applied vigorously.

Avenging—taking satisfaction for an injury by punishing the offender.

WORD LESSONS.

PAGE 44.

Accelerated — hastened, quickened, expedited.
Germination—budding, sprouting, growing.
Premature—early, forced.
Evolves—sends out, propagates, unfolds.

PAGE 45.

Eradicated—uprooted, destroyed.
Precaution—forethought, care.
Languish—wither, weaken, droop, fail.

PAGE 46.

Produce—crops, result, gain.
Elevated—raised, exalted.

PAGE 47.

Radiation—issue, rising, evaporation.
Atomies—mites, insects, animalculæ.

PAGE 48.

Fantasy — fancy, imagination, dreaming.
Inconstant — unstable, variable, changeable.

PAGE 49.

Condiment — sauce, seasoning, relish.
Farina—flour, meal, albumen.
Undeveloped—closed, folded, in embryo, latent.

PAGE 50.

Fragrance—perfume, scent, sweetness, freshness.
Deleterious—poisonous, injurious, destructive, pernicious.
Innocent—harmless, innocuous.

PAGE 51.

Stimulant — invigorator, exciter, spur.
Pernicious — injurious, hurtful, poisonous.
Re-action—revulsion, recoil, drawback.
Banish—drive away, expel, prevent.

PAGE 52.

Subsequent — following, future, later.
Indigenous—native, home-born.
Tropical—equatorial, hot.
Cylinder—roller, canister.

PAGE 53.

Nicety — accuracy, carefulness, exactness.
Indisputable—undoubted, indubitable, certain.
Nutritive—nourishing, wholesome, strengthening.
Imbedded — planted, sunk, deposited.

PAGE 54.

Giddy—dizzy, shaky, trembling.
Reflecting — shining, sparkling, glittering, gleaming.

PAGE 55.

Perpetual—constant, unchanging, everlasting, invariable.
Scourge — punishment, torture, plague.
Legion—troop, regiment, myriad.
Combination—compound, mixture.
Solution—liquid, dissolving.

PAGE 56.

Insoluble — undissolved, solid, imperious.
Adhesive—sticking, applicative.

PAGE 57.

Sediment—lees, scum, settlement.
Mottled—streaked, dappled.

PAGE 58.

Layers—rows, folds, strata.

PAGE 59.

Spherical—round, circular, globular.
Agitated — shaken, disturbed, stirred.
Revolutions—turnings, twistings, spinnings, circulations.

PAGE 60.

Diluted — weakened, watered, thinned.

Perforations — holes, apertures, orifices.
Serrated—notched, jagged, toothed.
Adjustable—movable, self-regulating.

Page 63.

Mirror—looking-glass, reflector.
Amalgamate—join, unite, mingle, combine.

Page 64.

Obviate—correct, counteract.
Substitute—exchange, supplant.

Page 65.

Dismount—unmount, leap off, descend.
Devotions—prayers, worship, services.
Prosperity—success, victory.
Memorable — remarkable, ever-remembered.
Gestures — movements, ways, looks.

Page 66.

Dedicate—devote, bestow.
Semblance — appearance, mien, visage.
Majestical—regal, royal, imperial.

Page 67.

Compassing—securing, usurping.
Contrite—penitent, sorrowful.
Withered — aged, decrepid, palsied.
Malleable—extensible, spreading.

Page 69.

Elevated—raised, poised, exalted.
Furnished — provided, fitted, clothed.

Page 70.

Practicable—possible, feasible.
Unmarked — unnoticed, disregarded.

Page 71.

Frantic—mad, wild, insane.
Tribute—*gift*, offering, present.
Attributes — epithets, *compliments*.

Pages 72, 73.

Permanent —abiding, continuing, unalterable.
Despicable—mean, low, contemptible, vile, worthless.
Unstable — unsteady, inconstant, wavering.
Manuscripts--writings, documents, letters.

Page 74.

Cavities — holes, hollows, depressions.
Essential—necessary, requisite.

Page 75.

Facility—easiness, readiness.
Pigment—colour, stain.

Page 77.

Enhance—increase, raise, heighten.
Department—portion, sphere, division.
Expressive—marked, intelligible, significant, emphatic.

Page 78.

Multitudinous—numerous, innumerable.
Terrestrial—earthly, sublunary.

Page 79.

Salubrity — healthfulness, wholesomeness.
Luminous—bright, shining, sparkling.

Pages 80, 81.

Determinate — fixed, certain, definite.
Prevalence — extent, abundance, universality.
Latitudes—regions, expanse, districts.

Page 82.

Productive — luxuriant, fruitful, lucrative, profitable.
Volatilized—evaporative, liquefied, vaporized.
Ductile--extensible, elastic.
Tenacity — toughness, adhesiveness.

Page 85.

Depressing — lowering, pushing down.
Consistency —thickness, substance, stiffness.

Page 86.

Commendations—compliments, respects.

Page 87.

Breeding—education, bringing up, culture.
Wench—girl, maid.
Inter—bury, lay in the grave.

Page 88.

Diminutive—small, little, minute.
Pyramid—cone, spire.

Page 89.

Illustrate—elucidate, explain, demonstrate, exemplify.
Intrigue—plot, contrivance, device.
Patronage—countenance, support, approval.

Pages 90, 91.

Impulse—spur, stimulant, push.
Capability — power, competency, capacity.
Contrivances—devices, expedients, means.

Page 92.

Damped—dulled, cooled, depressed.
Fuse—burn, melt, liquefy.

Page 94.

Spectator — beholder, looker-on, watcher, bystander.

Page 96.

Processes—operations, stages.
Protuberance — prominence, projection.
Texture—substance, consistence.

Page 97.

Brittle—breakable, fragile.
Property—quality, peculiarity.

Page 98.

Fabrication — manufacture, production.
Handicraft—handiwork, manual operation.
Incidental — belonging, natural, peculiar.
Draught—drawing, cartage.

Page 99.

Projection — jutting, protrusion, prominence.
Capital—money, property, accumulation.
Artizan—mechanic, skilled workman, artificer.

Page 100.

Contorted — twisted, twirled, writhed, screwed.
Lubricated — oiled, slippery, glazed.

Page 101.

Horizontal—flat, parallel, plane, level.
Spiral—twisting, winding.
Intermittent—irregular, alternate, inconstant.

Page 102.

Ingenuity — cleverness, talent, quickness, genius.
Dense—close, compact, thick.
Vibration—oscillation, trembling, quivering, reverberation.
Intercept—stop, impede, obstruct.
Converse — talk, discourse, hold dialogue.

Page 107.

Quaffed—drank deep, drained.
Plied — worked hard, laboured, applied.
Calendared — chronicled, noted, remembered.

Pages 110, 111.

Precipitate — submerge, plunge, deposit.
Maritime—seafaring.
Sensible—visible, perceptible, apparent.
Condense—thicken, solidify.
Compute—reckon, number, count, estimate.

WATER IN A STATE OF VAPOUR—(PAGE 110).

Precipitated—sent to the bottom, as sediment; spoken of a substance which, having been dissolved in a fluid, falls to the bottom when in contact with something capable of decomposing the compound.

Radiation (Latin, *radius*, a ray)—the shooting of anything from a centre, like the rays of light; sending out rays of heat from a heated body.

Strata (Latin, *sterno*, spread or lay)—layers of any deposited substance, as sand, clay, &c., spread out in succession one above another.

Maritime (Latin, *mare*, the sea)—by the sea.

Sensible (Latin, *sensus*, feeling)—that can be felt.

Condenses (Latin, *con*, together; *densus*, thick)—makes more close or thick.

Haloes—circles appearing round the body of the sun, moon, or stars, caused by the refraction or reflection of light upon thick vapour floating in the air.

Vegetation (Latin, *vigeo*, to flourish)—the process of growing, as plants, by nourishment derived from earth, air, and water.

Computed (Latin, *con*, together; *puto*, to think)—numbered, reckoned, counted.

Exhale (Latin, *ex*, out; *halo*, breathe)—breathe out or emit a vapour.

Clouds—collections of visible vapour or watery particles suspended in the air.

Sensible magnitude—of a size sufficient to be perceived.

Congelation (Latin, *con*, together; *gelu*, ice)—the process of passing from the liquid to the solid state, caused by cold.

Perceptible (Latin, *percipio* perceive)—able to be seen or felt.

THE CLOUD—(PAGE 115).

Aghast—struck with amazement, stupefied with sudden fright.

Rills—trenches, channels, small streams, or rivulets.

Jag—the tooth of a saw; so, a notch or sharp point of a rock.

Alit—alighted or rested.

Genii—fabulous spirits of the water.

Pall (Latin, *pallium*, a mantle)—a mantle or cloak thrown over dead bodies at funerals.

Peer—to peep, look narrowly.

Widen the rent—make the hole larger.

Million-coloured bow—the rainbow.

Sphere-fire—globe of fire (put for the sun).

Convex—bowed outwards.

Cenotaph—an empty tomb, erected as a monument.

QUESTIONS.—What was Lord William's crime? What was his dream? How was he punished? What is vapour? How is it made to discharge moisture? Name any floating vapours. When is water invisible? Prove it. How are dew, rain, snow, and hail formed? Give instances of the extent of evaporation? How are clouds formed? Whence does the cloud bring showers? How does it *sift* the snow? How much vapour can be got from an acre of snow? What are meant by the "orbéd maiden" and "sphere-fire"?

MICHAEL ANGELO—(PAGE 117).

Lorenzo—a Duke of Tuscany, belonging to the family of the Medici, and celebrated for his great patronage of art.

Model in clay—make clay models of statues.

Faun—a Roman rural deity, of human form, but with a short goat's tail, pointed ears, and projecting horns.

Granacci—a famous painter in Italy during the 13th century.

Michael Angelo—a celebrated painter, sculptor, architect, and poet, born at Florence in 1474.

Signor—the Italian for "sir," which is contracted from it.

Contemptuous (Latin, *contemno*, despise)—scornful, haughty, proud.

Sarcasm—a keen, cutting expression of scorn, a taunt.

Satire—keenness and severity of remark.

Cupid—the Roman god of love, son of Mercury and Venus, represented as a beautiful child with wings, blind, and carrying bows and arrows.

Antique—anything very old; but more strictly the work of ancient artists, as statues or paintings.

Connoisseur—a skilful or knowing person, a critic, judge, or lover of any art.

Mantua—an ancient city, to the north-east of Italy, in the Venetian dominions.

Florence—the ancient capital of Tuscany in Italy; for a short time the capital of the present restored kingdom of Italy.

Unqualified—without any drawbacks or exceptions.

Masterpiece—an exquisite piece of workmanship, such as could only be made by one who was master of his art.

Leonardo da Vinci—a famous artist, born at a village called Vinci, near Florence, in the year 1452; he was also an architect, sculptor, musician, and poet; skilled in all kinds of science, master of various physical exercises, and of wonderful bodily strength.

Pietà—a marble group representing the Virgin with the dead body of the Saviour on her knees, executed by Michael Angelo, when only twenty-three years of age, now at St. Peter's, Rome.

Brook—bear, or put up with.

Capricious—whimsical, changeable, fanciful.

Sensitive—having feelings easily excited.

QUESTIONS.—Who was Michael Angelo? Who was his patron? What work brought him into notice? Who was his fellow-student? What fault did Lorenzo find with his work, and how did he remedy it? How did he prove he made the Cupid? What was his Pietà? Why is his name on it? Who was Leonardo da Vinci? What were his excellencies?

DEW—(PAGE 122).

Phenomenon—anything as it appears to the senses, usually applied to those appearances of nature, of which we do not at once see the cause.

Thermometer (heat measurer)—an instrument for ascertaining the heat or cold of the air, in which mercury is inclosed in a glass tube.

Tissue—a very fine structure of fibre.

QUESTIONS.—How do we know dew does not fall? How is it formed? What are radiation and conduction? What matter is influenced by each of these? What circumstances are necessary for deposit of dew?

BRIGHTON AQUARIUM—(PAGE 126).

Terra-cotta—baked clay or burnt earth, anciently used for moulding decorations of buildings.

Frieze—a flat space between the cornice and top of a pillar in Grecian architecture, usually covered with sculptured ornaments.

Variegated—of different colours put alternately.

Granite—a mixture of various minerals, united into one rock, formed in the centre of the earth into a fused mass by heat.

Anemone—the name of several species of water animals, of a gelatinous substance, growing like plants from rocks, but able to move slowly from place to place, and feeding upon shell-fish.

Air-pump—a pump by which air is extracted from a vessel or forced into it.

Fernery—a place where ferns are grown.

Finny captive—fish which has been caught.

Dog-fish—a name given to several species of shark; the common kind is thinner and longer than a cod.

Gurnard—a fish of several species, the head covered with bony plates, and the gills having seven rays branching from them.

Atherine smelts—small fish, with rather flat upper jaws, six rays to the gills, and a side belt or line shining like silver, found in large quantities in the Mediterranean.

Turbot—a large flat fish, of a short, broad form, found on the coast of Durham and Yorkshire, and on the sand banks between the east coast and Holland.

Plaice—a fish, more flat and square than the turbot, growing to 8 or 10 lbs. each, and covered with red spots.

Turtle—a sea tortoise, but much larger than the land tortoise; found in all the seas of warm climates, sometimes 6 to 7 feet long, and weighing from 700 to 800 lbs.

Bivalve (Latin, *bis*, twice; *valva*, a door)—the general name given to oysters, having two valves or doors for their shells, which open and shut on a hinge.

Alligator—the American crocodile, which has a long naked body, four feet, a very wide mouth with very large teeth; the skin is brown, tough, and scaly at the side. It grows to 17 or 18 feet long, lives in rivers in warm climates, and principally eats fish. In winter it burrows in the earth, which it enters under water, working upwards, and lies torpid till spring.

Chub—a river fish, whose body is nearly round, the head and back green, the side silvery, the belly white. It frequents deep holes shaded by trees.

Tench—a fish of the carp family, but its scales are smaller, as also the fin on its back. It is found in most lakes of the European Continent, and in ornamental ponds in England.

QUESTIONS.—What is an aquarium? Where is there one on a large scale? How are the fish kept in it? How do they get air? Name some of them. Describe chub, plaice, turbot, tench, turtles. What are the bivalves and anemones?

THE GULF STREAM—(PAGE 131).

Circulation (Latin, *circum*, round) —*flowing* in a circle.

Propagated—continued or multiplied, spread or extended.

Cartilage—gristle; a smooth, solid, elastic substance, softer than bone.

Trending—running towards, tending, turning.

Equinoxial—within the region or climate of the equinoxial line or equator.

Equator (Latin, *æquus*, equal)—a supposed line round the centre of the globe, equally distant from the two poles, so called because it divides the globe into two *equal* parts or hemispheres; and as, when the sun is in it, the days and nights are of *equal* length, it is also called the equinoxial line (Latin, *æqua*, equal; *nox*, night).

QUESTIONS.—How does the gulf stream flow? What causes it? Why is its water hotter than that around it? Where is this difference most remarkable? What is the equator? Give other names of it, and explain them.

CURIOSITIES OF PHYSICAL GEOGRAPHY—(PAGE 134).

Sub-marine (Latin, *sub*, under; *mare*, the sea)—that which lies under the surface of the sea—*e.g.*, *submarine* rocks, *submarine* cable.

Bermudas—islands to the east of North America.

Maëlstrom—a violent whirlpool to the south of the Loffoden Isles.

Cephalonia—one of the Ionian Islands in the Adriatic.

Two of these lakes—Lake Erie and Lake Ontario.

The Rhone—a river rising in the Alps (in the Bernardine Pass), flows through the Lake of Geneva into the Gulf of Lyons.

Amazon—one of the largest rivers in the world; rises in Peru, near the west coast of South America, runs across the whole continent, and falls into the North Atlantic Ocean on the east coast; it is about 4,000 miles long.

Bordeaux—a city near the south-west coast of France, on the river Garonne.

Padua—an ancient city of Northern Italy, a few miles from Venice.

Mammals (Latin, *mamma*, the breast) — the name given to those animals that suckle their young.

Glacier (Latin, *glacies*, ice) — a mountain river frozen into a solid mass.

Fossilized (Latin, *fossus*, dug up) — properly, dug out of the earth; usually restricted to those organic substances which have become penetrated by particles of earth or metal, and are found imbedded in rocks or gravel.

Arid (Latin, *aridus*, parched) — dried up, parched.

Sulphuric acid—commonly called oil of vitriol, discovered at the end of the fifteenth century; it is made by burning sulphur and nitre in large leaden chambers; it is the most important ingredient in a galvanic battery (by which telegraphic messages are sent).

Artesian wells — are formed by putting a pipe down into the ground, until water is reached, which rises up the pipe by hydraulic pressure, no matter how great the depth.

QUESTIONS.—Where is the greatest depth of the ocean? What effect has depth on wood sunk in it? How does the colour of the ocean vary? What are the variations in its saltness? State the peculiarities of the Caspian and Dead Seas. Where are the highest waves? How deep do they go? What would be the shortest way from Russia to North America, and why is it not used? State anything about the heat of the ocean. Describe the Maëlstrom. Give the peculiarities of the Rhone, Amazon, and La Plata; and describe their course. How does gravitation vary? Say what you know about *glaciers*. Where are the highest city, the largest plain, and highest pass?

PLEASURES OF MEMORY—(PAGE 141).

Reverend—venerated on account of their age.

Pensive (Latin, *penso*, to weigh or consider)—thoughtful; engaged in serious meditation; sorrowful.

Teems—is full of, abounds in, overflows with.

Hazel copse—a plantation of hazel nut trees.

Gipsy—corrupted from *Egyptian*, as gipsies were thought to have come from Egypt; but it is now supposed they came originally from Hindostan, about A. D. 1408, being driven out when India was ravaged to spread the Mahommedan religion; they belong to the lowest class of Indians, called Pariahs, and probably reached Europe through Egypt. They are a wandering race, retaining the eastern customs and complexion, and not remarkable for honesty.

Owlets—little owls.

Rifled roost—fowls stolen from the hen-coops of the farmer.

Sybil—amongst ancient heathen nations the sybils were women said to be gifted with the spirit of prophesy; their oracles (*i.e.* prophecies) were written in verse, and upon the leaves of trees; the name is applied to any woman professing to tell fortunes; here it is used for the gipsy.

Traced the line of life—professed to read a person's fortune by looking at the marks in the palm of the hand.

QUESTIONS.—Where is Dover? What is the beauty of Kent? How is England described as better than the rest of Europe? Describe the village scene at twilight. Where was the poet born? Who was his best earthly friend? What had become of his school? Where was the gipsy's camp? Describe the gipsy. Where did gipsies originally come from? State their peculiarities.

CHANGES IN THE ATMOSPHERE—(PAGE 142).

Subtile (Latin, *subtilis*, thin)—a term applied to air or vapour denoting its delicacy, rendering it easy for one to move about in it without feeling its touch.

Mean state—average condition.

Barometer, commonly called weather glass—an instrument for measuring the weight or pressure of the air, and so give warning of change in the weather.

Fahrenheit, Celsius, Réaumur—the inventors of three different methods of making a thermometer; that of the first is used in England; the second, called also *centigrade* (*i.e.*, 100 degrees), is used generally on the Continent, particularly in France; and the third is commonly used in Germany.

Inspection (Latin, *in*, into; *specio*, to look)—a looking into, close or careful survey.

Pulley—a small wheel, moving on an axis, having a groove cut in its circumference, over which a cord passes.

Dial-plate (Latin, *dies*, a day)—the plate or face of a clock on which figures are marked with hands pointing to them from the centre to show the time of day; also used of any similar index.

Questions.—How do we measure changes of atmosphere? What are these changes? Why cannot we tell changes without measuring them? Why do wood, iron, and marble of the same heat *feel* differently? What causes expansion of fluids? What liquid is best for measuring temperature, and why? How is a thermometer made? What measures the changes in the *weight* of air? What is its practical use? How is it made?

MECHANICAL EFFECTS OF THE AIR—(Page 148).

Windmill—a mill which receives its motion from the force of the wind acting upon sails or vanes (generally four in number), and used for grinding corn, pumping water, &c.

Etesian winds (Latin, *etesius*, yearly)—yearly or annual winds (answering to the monsoons of the East Indies), applied to the periodical winds in the Mediterranean Sea, from whatever quarter they blow.

Submergences (Latin, *sub*, under; *mergo*, to sink) — the acts of sinking or subsiding under water.

Investigations (Latin, *in*, upon; *vestigo*, to follow a track) — minute searching or careful inquiries into doubtful matters.

Temperate—varying but little.

Proximity (Latin, *proximus*, nearest) — nearness or close approach.

Questions.—What is meant by a mechanical agent? How is air one? State all the work you know that is done by air. What is the *belt of calms*, and what the *trade winds?* How are they caused? What are *monsoons*, and *etesian* winds, and simooms? Where do each prevail? Where are the worst hurricanes felt, and by what names are they called?

THE TIDES.—(Page 151).

Navigation (Latin, *navis*, a ship; *ago*, to drive)—the art of managing or sailing a vessel on the sea.

Conducive (Latin, *con*, together; *duco*, to lead)—leading or tending to a certain point or end.

Age of the moon—the age of the moon is the time of one revolution, or the period from one change of the conjunction of the moon with the sun to another. Its average length is 29 days 12 hours 44′ 2″. This period is called (from the moon) a *month*, and is divided into four quarters: the first quarter commences when only a small portion of the moon is visible to the earth, when we call it a new moon; the second, when half the moon is visible; and the third, when the whole or full moon is to be seen; the fourth, when it declines from the half. There are thirteen of these periods in a year. A *harvest moon* is the full moon nearest the autumnal equinox, when it rises for several days at the same time, instead of 52 minutes later every day.

Fluctuation (Latin, *fluctus*, a wave) —a motion like that of the waves, a sudden rising and falling.

Gravitation (Latin, *gravis*, heavy) —the force by which bodies are drawn or forced towards the centre of the earth or other centre; this force acts throughout nature, so that all bodies have a tendency to approach each other in proportion to the quantity of their matter.

Attraction (Latin, *ad*, to; *traho*, draw) — the power in bodies which draws them together.

Magnet—the loadstone, an ore of iron which has the peculiar properties of attracting metallic iron, of pointing to the poles, and of dipping or inclining downwards; this power is communicated to iron by rubbing it with loadstone.

Perfect sphere—A solid body contained under a single surface, which in every part is equally distant from its centre.

Revolution (Latin, *re*, back; *volvo*, roll)—the completion of a circulation and return to the starting point.

Meridian (Latin, *meridies*, noonday)—a great circle supposed to be drawn through the poles of the earth and round its surface from north to south, represented on a map by the line of longitude; every place on the globe has its meridian, and when the sun arrives over this line, it is mid-day or noon at that place.

Flood tide—the whole interval between high and low water is called *a tide;* as the water rises it is said to flow, and the rising is called the *flood* tide; as it falls it is said to ebb, and the falling is called the *ebb* tide. The different heights of tide succeed each other in a regular series, which is completed in 15 days; the greatest is called a *spring* tide, the least a *neap* tide.

QUESTIONS.—What is the use of *tides* to ships about to sail? How do tides conduce to health? What regulates the tides? Explain this. How often does the tide rise? When are the highest and lowest tides? What are they called? What are *flood* and *ebb* tides? What causes a difference in the tides of narrow seas?

LESSONS IN GEOLOGY—(PAGE 160).

Analyzes—resolves a body into its elements, or separates a compound into its composite parts.

Boulders—large rounded blocks of stone lying on the surface of the ground, different in composition from the rocks around them, and, therefore, they must have been rolled from a distance.

Oxygen—an invisible, elastic fluid, which is the vital part of the air, and the supporter of ordinary combustion.

Grotto—a large cave or den, formed in the earth by a current of water or an earthquake.

Grotesque—jagged and broken, irregular, like the side of a grotto; wildly formed, instead of with artistic nicety.

Delta—the name of the Greek letter D, of a triangular shape, Δ; used of the island formed by the deposit of soil brought down by the Nile, whose stream it has separated into two main branches or forks; the name has been extended to similar triangular deposits at the mouths of great rivers.

Coral islands—islands or reefs formed by a marine animal of the polypus kind, and really composed of the shells of those animals. The South Sea Islands are mostly coral rocks covered with earth.

Sponge—a porous marine substance found sticking to rocks and shells under water, particularly about the islands of the Grecian Archipelago and the Red Sea. It is an animal, not a vegetable, production.

Elaborate (Latin, *e*, out; *laboro*, work)—work out, extract, and work into something else.

QUESTIONS.—What is geology? What is its practical use? What is the *earth's crust*, and by what is it greatly influenced? What are strata? What is the benefit of volcanoes, and what their cause? How are sponges and coral produced, and where are they found?

VARIETIES OF ROCKS—(PAGE 163).

Stratified—arranged or disposed in layers or strata.

Mineral constituents—the minerals or metals which compose it.

Imbedded contents—articles contained in the strata, but not of the same nature.

Petrified (Latin, *petra*, a rock; *fio*, become)—used of a vegetable or animal substance, converted by decomposition into stone.

Minutest—the very smallest or finest.

Consolidated—made into a solid mass.

Carbonated waters—waters containing carbonic acid gas.

QUESTIONS.—What are the two great groups of rocks? What is the intermediate group? Which constitute the *base* of the system, and how were they formed? What distinguish *stratified* rocks? What determines the *age* of a rock? Describe the process of fossilization.

FIRE-FORMED ROCKS—(PAGE 166).

Conjectured—guessed at, supposed, but not clearly ascertained.

Depositories—places where anything is laid up in store.

Safety-valves—little doors or openings in a steam engine, allowing the steam to escape when its confinement becomes dangerous; applied to any similar outlet.

Molten—melted.

Borax—a salt formed by the combination of boracic acid with the marine alkali soda.

METAMORPHIC ROCKS—(PAGE 167).

Metamorphic—rocks which have undergone a transformation.

Marble—a name given to various kinds of limestone with a fine grain, and admitting a beautiful polish; found in great varieties in Italy, and throughout the Mediterranean, most of its islands being of this rock; also found in Derbyshire and Cornwall.

Talc-schist—a kind of magnesia found in broad, flat, smooth plates, of a shining appearance, often transparent, and used in China for window glass.

Mica-schist—a slaty kind of rock composed of mica and quartz, found in plates (sometimes 18 inches in diameter), having a shining surface. These plates can be split, and reduced to a thickness of not more than a millionth part of an inch; and, being transparent, they are used in Prussia for window panes.

Types—the primary forms or original germs from which varieties have sprung.

Crocodiles—animals living both on land and in water, having naked bodies, with four feet and long tails. They grow to the length of 16 or 18 feet, run swiftly on land, but cannot easily turn themselves. They inhabit the large rivers of Africa and Asia; but lay their eggs in the sand to be hatched by the sun.

QUESTIONS.—What are *fire-formed* rocks? What are they generally called? How do we know fire exists in the earth? What is the use of these rocks? What are *metamorphic* rocks? By what general name are they best known? How are they formed into marble? Where is the best marble for statues, and what is its colour? What are fossils, and how formed? What remains of animals are found that do not now exist? What useful article belongs to this class, and from what formed?

YORKSHIRE—(PAGE 169).

The Vale of Yorkshire—the two great valleys of Yorkshire are Wharfdale, and Wensleydale.

Reservation—allowance, respect.

Sward—an old English word for a grassy surface of land, generally used of meadow land.

Beck—an old English word used in the northern counties for a small stream.

Stalactites—a kind of carbonate of lime in a conical or cylindrical form, hanging like icicles from the roofs and sides of caverns. They are caused by the filtration of water through the pores of limestone rocks.

Argillaceous (Latin, *argilla*, clay)—used of earth, or rock formed from clay.

Lias—the name of a series of strata of clay.

Oölitic—composed of oölite (or *egg* stone), a species of limestone composed of globules clustered together, varying in size from that of a small pin's head to that of a pea. This series includes all the strata between the iron, sand, and the red marl (or clay) below.

Shale—a slaty clay of a bluish or yellowish gray colour; generally overlaying coal beds, easily dissolved in water, unless baked in the fire, when it becomes hard, and is used as ballast for railroads.

Rhinoceros (Latin, *rhino-ceros*, nose-horn)—a thick-skinned quadruped, nearly allied to the elephant and hippopotamus; found in India (especially on the banks of the Ganges) and Southern Africa; some have one horn on the nose, some two.

Plesiosaurus—an extinct animal of the lizard kind, found embedded in lias and clay; it had the head of a lizard, with a very long neck (almost like the body of a serpent), the teeth of a crocodile, the trunk and tail of a quadruped, and the paddles of a whale.

Epoch—any fixed time or period, from which succeeding years are numbered.

Dialect—the form or idiom of a language peculiar to a province.

Stalwart—brave, bold, strong.

Fastidious (Latin, *fastidium*, disdain)—difficult to please, over nice.

Diminutive—a word used to express a little thing of the kind.

Incumbent (Latin, *cumbo*, lie; *in*, upon)—pressing upon one, necessary, indispensable.

SAXON WORDS—(PAGE 177).

Saxon words—words in our language that are of Saxon origin.

Spells—charms.

Aspect (Latin, *ad*, to; *specio*, look)—view, sight, position.

Myrtle (Latin, *myrtus*)—an evergreen shrub with an upright stem 8 or 10 feet high; it branches from a close full head, and it has numerous pale flowers. The leaves are oval, branching from opposite sides of the stem, and marked with little dots. They (as well as the flowers) are aromatic and astringent.

Its own unclouded realms—it is a native of all the countries around the Mediterranean, and of the temperate parts of Asia, often growing in thickets.

Elm (Latin, *ulmus*)—one of the chief timber trees of England, ranking next to the oak, noted for the rapidity of its growth and its hardness; it grows in very poor soil; there are 19 species, 6 of which are natives of Britain.

Oak—a considerable number of species are found in the temperate parts of Europe, and at least 50 have been found in North and South America; it was held sacred by Greeks, Romans, Gauls, and Britains; two species are natives of Britain, and when cut down (at the age of from fifty to seventy years) they form the best timber known for supporting a weight, resisting a strain, and not splintering by a cannon shot; hence its value in shipbuilding. The common oak grows to a height of from 60 to 100 feet, with a trunk of from 6 to 12 feet in circumference. Its bark is the best for tanning, its leaves are useful in medicine, and its galls are the chief ingredient in writing ink.

Mighty piles—the Egyptian Pyramids.

Grecian fanes—the ruins of heathen temples.

Ivy—a native English plant, but found through most of Europe, and in many parts of Asia and Africa; the leaves are smooth and shining, but varying in form; it attains a great age, and was held sacred in Greece and Egypt.

Alfred—Alfred the Great, a Saxon king, A.D. 872, who defeated the Danes, and founded the University of Oxford.

Shrined—made sacred.

QUESTIONS.—For what is Yorkshire distinguished? Name some of its rivers, birds, heights, waterfalls, and principal mountains. What old castles and abbeys are found there? What is its extent, and how has it varied? What king was murdered in Yorkshire? What animal remains have been found in it? How may this county be described *geologically* and *legally*? Describe the pursuits of the people. Give evidence of the early Teutonic and Brigantian inhabitants. Explain some of the peculiarities of dialect. Give instances of *Saxon* words now in use. What history is contained in them?

WORD LESSONS.

PAGE 115.

Fettered—bound, chained, enslaved.

Lured—enticed, attracted.

Sanguine—hopeful, hearty.

PAGE 116.

Glimmering—glittering, glistening, sparkling.

Reel—stagger, quiver.

Hurricane—tempest, tornado.

PAGE 117.

Mutilate—maim, break, disfigure.

PAGE 119.

Contemptuous—scornful, haughty, proud, disdainful.

Sarcastic—cutting, sneering, reviling.

Satire—caricature, burlesque, ridicule.

Antique—ancient, old, curious, quaint.

PAGES 120, 121.

Veracity—truthfulness, genuineness, trustworthiness.

Indelible—imperishable, ineffaceable.

Capricious — whimsical, fanciful, variable.

PAGE 123.

Phenomenon — wonder, mystery, curiosity.

PAGE 129.

Scavengers—sweepers, dustmen.
Bivalve — double doors, folding-doors.
Alligator—crocodile.
Circulation—rotation, revolution.
Propagate—continue by multiplication of itself, generate, produce.
Velocity — speed, swiftness, alacrity.

PAGE 133.

Adrift—uncontrolled, loose.
Arid—dry, parched.

PAGE 140.

Trending—tending, turning, verging.
Submarine—under water, sunken.
Axis—centre, axle, spindle.

PAGE 141.

Pensive — thoughtful, reflecting, sorrowful, meditative.
Teems—swells, abounds in, overcharges.
Gipsy — wanderer, nomad, vagabond.
Rifled—plundered, robbed, stripped.

PAGE 147.

Inspection — examination, supervision, survey.
Submergence—subsiding, sinking, depression.
Investigation — tracking, search, exploring.
Proximity—neighbourhood, nearness, nighness.

PAGES 151, 152.

Navigation — sailing, making a voyage.
Conducive—leading, tending.
Fluctuation—wavering, unsteadiness, vacillation.

PAGES 153, 155.

Gravitation—sinking, weight, attraction.
Artificial — unnatural, manufactured.

PAGE 161.

Grotto—cave, cavern, arbour.
Grotesquely—grotto-like, jagged, rough.

PAGES 163, 165.

Elaborate—work out, solve, compose.
Consolidate—amass, solidify, combine.

PAGE 166.

Conjecture—guess, suppose, imagine.

PAGES 169—177.

Dialect—brogue, lingo, idiom.
Stalwart—brave, bold, strong.
Fastidious — particular, delicate, nice, dainty.

TIDES OF RIVERS—(PAGE 179).

Becalmed—stopped from motion or progress from want of wind.
Undulation (Latin, *unda*, a wave) — a waving motion of the water.
Extremities (Latin, *extremus*, the last) — the utmost parts or ends.
Beach—the shore of sea, lake, or river washed by the tide and waves; the strand.
Small craft—little ships or boats.

QUESTIONS.—What is meant by a *tide-wave* going 100 miles an hour? How fast does it move in the Channel? Where is it strongest? What happens when it reaches the mouth of a river? How is its effect shown in American rivers? Why does it keep on rising at London Bridge when it is falling at Gravesend? Explain the illustration fig. 3.

DISTRIBUTION OF PLANTS—(PAGE 183).

Palms—the name of many species of plants (chiefly inhabiting the tropics), with very lofty trunks and gigantic foliage at their summits; there are about 1,000 species of palms, and scarcely one in which some useful property is not found, as wine, oil, wax, flour, sugar, salt, thread, and material for all kinds of utensils and weapons, as well as habitations.

Balsams—a name given to a genus of plants, mostly annual, found in India, from which oil and perfumes are gained; a hardy tree of the same kind in South America.

Distribution—being placed in separate localities.

Anomalies—deviations from established rules or laws.

Irrigation (Latin, *in;* and *rigo,* to water) — the act of artificial watering of plants or crops.

Gorgeous—showy, glittering with gay colours.

Banyan tree—a tree in India, which throws out supports from the horizontal branches, which take root as soon as they reach the ground, and throw out fresh branches of their own; on the banks of the Budda there was one which sheltered under its shade an army of 7,000 men.

Camphor tree—the tree from which camphor is obtained; the stem is thick, the bark is brown, and the wood soft; to get camphor the tree is cut down and divided into pieces, the camphor being found in white flakes near the centre; it is then soaked and washed in soapy water, and passed through three sieves of different textures.

Kangaroo—a quadruped (peculiar to Australia), whose fore legs are small and short, the hind ones long and powerful; the former are only used for digging and feeding, the latter for movement; they are sometimes 6 feet high, feed on vegetables (particularly grass), and are gregarious. The kangaroo has a pouch in the abdomen, in which it carries its young after birth.

Dingo—an Australian wild dog, of a wolf-like appearance, which is extremely fierce, but does not bark; the ears are short and erect, the tail bushy, the hair of a reddish dun colour.

Puma—a rapacious quadruped of the cat family, found in the tropical parts of America.

Gorilla—a large species of ape, bearing the closest external resemblance to man of any member of the brute creation, but distinguished from him by the internal formation of the skull, the position of the thumb and great toe, and the absence of speech and intellect.

Jaguar—the American *ounce* of Brazil (belonging to the cat family), the largest and most formidable quadruped in America; it is marked with large dark rings, with a central dark spot in each.

Ourang-outang (literally "the wild man of the woods")—a quadruped confined to Borneo, Sumatra, Malacca, and approaching very nearly to the appearance of man, but quite incapable of walking in a perfectly erect posture; the arms reach to the ankle joints, the body is covered with hair of a coarse brown colour, from 5 to 6 inches long; it feeds on fruit, and sleeps in trees.

Camel—a large quadruped used in Asia to carry burdens; the Arabian camel (or dromedary) has one hunch on its back, the Bactrian camel has two; in the east its hair is manufactured into carpets, wearing apparel, and covering for tents; but in this country it is only used for pencils or brushes for painting.

Cuckoo—a bird which gets its name from the noise it makes; it is about the size of a small pigeon, visiting this country about the middle of April, and leaving the first week of July, and going southwards; but where it spends the winter is not well known; it lays its eggs in the nest of some other bird, generally in that of the water-wagtail.

Swallows—birds of the sparrow genus, of which there are several species (the common one being the chimney swallow, the sand martin, and the house martin), remarkable for their thick plumage, length of wing, and rapidity of flight; they visit this country during summer, and pass more of their time in flying than any other of our birds.

Phosphorescent—shining with a faint light, without sensible heat, exhibited by certain animals, by vegetable and mineral substances, and especially by fish.

Spangled—set or covered with small brilliant bodies which sparkle.

Fire-fly—a species of fly which has on its belly a spot that shines; another species *emits* light as it flies.

Whale—the common name of a genus of aquatic mammalia of immense size; the common Greenland whale is valuable on account of the oil and whalebone it supplies; its length is about 60 feet, and its greatest circumference about 30 to 40.

QUESTIONS.—Name some of the plants in tropical climates. How are they *distributed?* What is the group of animals peculiar to a country called? Can it be changed? What is the *vegetation* called? How far can it be changed? How are the fauna and flora dependent on each other? Name some of the *characteristic* fauna and flora of Australia. What is the lion in America? How many kinds of insects are known?

LIONS—(PAGE 187).

Menagerie—a collection of wild animals for exhibition, a yard or place in which wild animals are kept.

Buffalo (Latin, *bubalus*)—a species of the ox tribe, found in most of the warmer countries of the eastern continent; it is larger and less docile than the common ox, and is fond of marshy places and rivers; large herds are kept near Salerno, in Italy. The name is applied to wild oxen generally, and particularly to the wild bison of North America.

Avidity (Latin, *avidus*, greedy)—eagerness, greediness.

Traits—features or marks of character.

Hottentots—natives of the southern *extremity* of Africa.

[illegible]*strate*—to pierce, to make one's way into, to pass into the interior.

Bushmen or Caffres—*woodsmen*, a name which the Dutch gave to the wild and ferocious inhabitants near the Cape of Good Hope.

Prowling—wandering about in search of prey.

Lair—a place to *lie* down in, a place of rest for wild beasts, and so the rough natural couch of a savage.

Indefatigable (Latin, *in*, not; *defatigo*, to weary out)—unwearied, not yielding to fatigue.

Discomposing—Unsettling, put out of one's order, disturbing.

Interference—meddling with other persons' concerns, stopping or delaying one's actions.

Indolent (Latin, *in*, not; *doleo*, to be pained)—indisposed to labour, inactive, idle.

Skulking—lurking, sneaking off into retirement.

QUESTIONS.—Give instances of a lion's strength. What claim has it to the title of "lord of the forest"? Tell in your own words the traveller's journey from the Cape of Good Hope. What is the sort of weather that rouses the lion? Describe a lion-hunt. What animal of this kind is much superior in noble qualities? What are those qualities?

CRUELTY TO ANIMALS—(PAGE 191).

Inadvertent (Latin, *in*, not; *verto*, to turn)—not turning the mind to, headless, careless.

Vermin (Latin, *vermis*, worm)—all noxious little animals destructive to grain or other produce, and hurtful to man and beast.

Refectory (Latin, *re*, again; *facio*, to make)—a room for refreshments.

Paramount—superior to all others, eminent.

Imminent—threatening, overhanging.

Righteous limitation—the limit or extent, which is allowed by right.

Outrage—violence offered to injure a person or thing; serious wanton mischief.

QUESTIONS.—What lesson is taught us by these lines? Why should we not crush a worm? When may we kill animals or insects? What is the "rule of righteous limitation" to the act?

MAN—(PAGE 192).

Receding (Latin, *re*, back; *cedo*, retire)—moving back, withdrawing, retreating.

Oval (Latin, *ovum*, an egg)—egg-shaped.

Release of the slave—the abolition of the slave trade by an Act of the English Parliament in the reign of George III., owing to the advocacy of William Wilberforce.

Aquiline (Latin, *aquila*, an eagle)—shaped like an eagle's beak.

Malayan peninsula—a projection of the Asiatic Continen to the south of the eastern part of India.

QUESTIONS.—In what important point does man differ from plants and animals? Why can man inhabit any part of the globe? How many varieties of man are there? Describe the peculiarities of each. Which may probably be classed together? What great conquering nations have died out?

LABOUR AND INTELLECTUAL ATTAINMENT—(PAGE 196).

Legends (Latin, *lego*, to read)—tales of fiction, or traditions which are not authenticated; old stories, or fables.

Mythólogy—a system of fables or stories, opinions, and doctrines respecting the gods and goddesses of ancient heathen nations.

Artificer (Latin, *ars*, art; *facio*, make)—one whose occupation requires skill or knowledge of a particular kind.

Untrammelled—not fettered, or restricted, free.

Genial—gay, merry, cheerful.

Subservient (Latin, *sub*, under; *servio*, to serve)—submissive, or holding a subordinate place.

Humanizing—softening, rendering humane, subduing rough dispositions.

Intercourse (Latin, *inter*, between; *curro*, to run)-running or passing between; communication, interchange of thought or civilities.

THE DOUGLAS—(PAGE 198).

Jennet—a small light Spanish riding horse.

Simperer—one who smiles in a simple, silly manner.

Pageant—a show for entertainment, anything showy and intended for pomp.

Quaint—curious, singular, fanciful, generally referring to something out of fashion.

Burghers—the inhabitants of a burgh or borough, who enjoy the privileges of the borough of which they are freemen.

Hostage (Latin, *hostis*, an enemy)—a person delivered to an enemy as a pledge to secure the performance of a treaty, or the good behaviour of the people he represents.

Hurl the massive bar—throw the sledge hammer.

Begirt—surrounded, placed all round; encompassed.

Antler'd prey—the stag.

Venison—the flesh of the deer; put here for the stag itself.

Buffet—a blow with the fist; a box on the ear.

Gore—thick or clotted blood.

Gauntleted—covered with a boxing glove, usually made of iron, and covered over the fingers with small iron plates, and iron rivets; worn by horse soldiers.

Mis-array—disorder; want of method; broken ranks.

Marr'd—spoilt.

Festal day—holiday.

Fealty (Latin, *fidelis*, faithful)—faithfulness to a lord, or superior; loyalty.

Mate—husband.

Verge—the extreme end of anything; the brink, edge, border.

Stayed—stopped.

Prattlers—little children.

Trailing—drawn along the ground, not in battle array, but in dejection or submission.

QUESTIONS.—Describe the procession of King James from the castle. To what were they going? What was the first contest, and who won it? Who won the second, and how? Who cheered him? What did he do with the prize? What was said about the winner? How was the last won? What made Douglas angry, and how did he show his anger? What effect had this on the king, the nobles, and the people? What was done with Douglas, and how did he quieten the people? Why had he no right there?

DEVELOPMENT OF THE INTELLECT—(PAGE 204).

Regenerate—to give new life and new aims.

Meritorious—deserving of praise.

Ethereal—belonging to heaven, immortal, divine.

Architect—a person skilled in the art of building, or drawing designs for buildings.

Consign—deliver into the possession of another; commit for safe keeping.

Cloister—a *close* or inclosed place; used of a monastery or nunnery.

Pre-eminent—superior over all; supreme.

Chime in—sound in harmony, suit with, or agreeable to.

QUESTIONS.—How may the humblest calling be elevated? How must a man hope to rise? Of what should he never "lose hold"? Why? What is the true position of religion?

BENEFITS CONFERRED BY EDUCATION—(PAGE 206).

Speculation—buying articles in *expectation* of a rise in price, and so making more than ordinary profit, and running the risk of more than ordinary loss.

Acquisition (Latin, *ad*, to; *quæro*, to seek)—the act of obtaining or gaining that which we do not possess.

Accomplishments—things which cause elegance of manner, or which make a person attractive, but confer no solid advantage.

Exigencies (Latin, *ex*, and *egeo*, to want)—the wants or needs.

Virgil—A Roman poet in the time of Augustus Cæsar, who wrote a poem on the taking of Troy, and voyage of Æneas to Italy, and the foundation by him of the Roman nation. This book was called the Æneid. He also wrote several other poems.

Easier circumstances—better off, richer.

Genial relaxation—pleasant amusement or refreshing exercise.

QUESTIONS.—What *three* things are to be prized above all other acquirements? To whom do colleges and mechanics' institutes give education? What is most needed besides? Who were Homer and Virgil? What did they write? What is an academy, and why is it so called?

WORD LESSONS.

PAGE 179-186.

Undulation — sweeping, curving, waving.

Beach—shore, strand.

Gorgeous — glowing, showy, resplendent.

Spangled — starred, spotted, gemmed, glittering.

PAGE 187.

Prowling—lurking, skulking, creeping.

Penetrate — pierce, transfix, obtrude.

Indefatigable — unwearied, untiring, laborious.

Indolent—idle, inactive, lethargic, lazy.

PAGE 191.

Refectory—dining-room, restaurant, refreshment-room.

Paramount — superior, eminent, excessive.

Imminent—overhanging, threatening, warning.

Outrage — violence, mischief, assault.

PAGE 192.

Receding — retreating, retiring, withdrawing.

PAGE 196.

Legends—traditions, tales, fables, myths.

Begirt— surrounded, girdled, encircled.

Fealty—loyalty, fidelity, faithfulness.

PAGE 204.

Meritorious—praiseworthy, commendable, exemplary.

Ethereal—heavenly, aërial, airy, divine.

Pre-eminent—superior, supreme, excellent.

WATER—(PAGE 209).

Hydrogen — an elementary substance only known to us in the form of gas. It is one of the elements of water, and of all vegetable and animal products. It is the lightest body in nature, therefore best fitted for filling balloons.

Aëriform (Latin, *aër*, air; *forma*, form)—in the shape of air.

Cohesion (Latin, *con*, together; *hæreo*, to stick) — the act of sticking together, the natural tendency which the particles of bodies have of sticking to each other.

Hermetically sealed — perfectly closed so that no air, gas, or spirits can escape; this is done by melting the neck of a vessel, and fusing its sides together, till the opening is accurately closed.

Questions.—Of what is water composed? What are they? In what three forms is matter found? Which substance is found in all three? What two opposite forces act on all bodies? Explain them. What effect has heat on particles? What causes water to change its form, and how? What would have happened if the heat of the earth had been a little greater or a little less? At what heat will quicksilver boil? What happens when water freezes? Why are not the fish frozen to death?

BRITISH FREEDOM—(Page 213).

Dark—obscure.

Salutary bands — wholesome checks.

Shakespeare—a great writer of plays, born at Stratford-on-Avon, 1564, died 1616.

Milton—a great sacred poet who went blind. He wrote *Paradise Lost* and *Paradise Regained*. Born in London, 1608, died 1674.

Property (Latin, *proprius*, one's own)—that which is natural to, or the peculiar quality of anything.

Surveying—the art of measuring and drawing plans of portions of the surface of the earth, with their positions, divisions, and features.

Attains—reaches.

Column (Latin, *columna*, a stalk or stem)—properly a solid cylindrical body standing perpendicularly, but used of any body pressing perpendicularly upon its base, and the same thickness as its base, as a column of water, &c.

Commotion (Latin, *con*, together; *moveo*, move) — a movement, agitation, disorder.

Paradoxical — that which seems to be contrary to common sense, and contrary to received opinions.

Solved (Latin, *solvo*, to loose)—clear up what is obscure, explain what is difficult.

Tantalus — a king of Lydia in Asia Minor, who was condemned to be plunged into water with choice fruits hanging close to his face, which was so fastened that he could neither reach them nor the water, from which comes the word *tantalize*.

Exterior (Latin, *exterior*, outer)—on the outside of the outward surface.

Questions.—What blessing has flowed unchecked to us "from dark antiquity"? How should we keep it? Who were Shakespeare and Milton? What is the most level surface we know? What use do we make of it? What is a *spirit-level*, and how used? Why are liquids level? Explain fig. 1. Why is the basin never full? What is the "cup of Tantalus;" how is it made? Who was *Tantalus?*

THE FLAME OF A CANDLE—Part I.—(Page 216).

Chemistry — here used for the composition and the law by which it is produced, and by which it acts.

Experiment (Latin, *experior*, to try)—a trial; an attempt designed to discover some principle or effect, or to exhibit it when discovered.

Wick—a number of threads of cotton loosely twisted together, by which the melted tallow in candles is drawn up to be burnt; it is so called from an old Saxon word meaning *alive*, a corruption of the word *quick*.

Devices — artificial contrivances, patterns, or emblems.

Effectually—successfully, producing the intended effect.

Chandelier (Latin, *candeo*, to shine)—a frame, with branches for candles, suspended from the ceiling.

Languidly (Latin, *langueo*, to droop)—weakly, feebly, dimly.

Vitiated (Latin, *vitium*, a fault)—rendered faulty, impure, or defective.

Luminosity (Latin, *lumen*, light)—brightness, the quality of being bright or shining.

Questions—Describe a candle. What is meant by its *chemistry?* What makes the flame *oval?* Prove flame cannot exist without air. Why does the flame go out under a tumbler? Where in a flame is the pressure of air strongest? Why do gas flames turn upwards, when the jet sticks *straight out?* How did the ancients mark a flame and water? How is the *cup* formed round melted tallow? Why do candles run and gutter in a very hot room? Why do those at the *bottom* burn better than those at the *top* of a chandelier? How does the tallow rise up the wick? What is the wick? How does it have *capillary attraction?*

DUKE OF BUCKINGHAM—(Page 220).

Premises—the grounds or propositions on which a conclusion is formed.

Long divorce of steel—the axe of the executioner, which is to separate the soul from the body.

O'—put for "of" or "in."

Furniture—here used for ornaments or materials for insuring comfort.

Loose—lax, too open or confiding.

Lord High Constable—formerly the seventh officer of the crown; he had the care of the common peace, and was a judge of the court of chivalry; its power was so improperly used that it was abridged in the reign of Richard II., and forfeited at the execution of Edward Stafford, Duke of Buckingham, 1521.

Questions.—What was the name of this Duke of Buckingham? What was his office? When and why was it given up? What was Buckingham's prayer for the king? Who was the king? What good advice did Buckingham give?

CAPILLARY ATTRACTION—(Page 223).

Immersed—plunged or sunk.

Manifests—shows, displays.

Elevation (Latin, *e*, out; *levo*, to raise)—the act of raising or conveying from a lower to a higher level.

Depression (Latin, *de*, down; *premo*, to press)—the act of sinking or being pressed down; a hollow or falling-in of a surface.

Stationary (Latin, *sto*, stand)—standing still.

Filaments (Latin, *filum*, a thread)—threads, fibres.

Perceptible (Latin, *percipio*, to perceive)—that which can be perceived by any of the senses.

Hyperbola—properly the arch or curved line described by anything shot up from the ground, in its course through the air, from its starting point to its fall.

Adhere (Latin, *ad*, to; *hæro*, stick)—to stick or attach itself to.

Repulsion (Latin, *re*, back; *pello*, to drive)—that power by which bodies are made to recede or retire from each other.

Predicting (Latin, *pre*, before; *dico*, to say)—foretelling, or declaring beforehand that any event may or will take place.

Bore—the hole made by boring, the cavity or hollow of a cylinder or tube.

Mutilated (Latin, *mutilo*, to cut off)—cut or broken off, deprived of a limb.

Animal fluids—the liquids of the body, such as blood, &c.

Processes (Latin, *pro*, forwards; *cedo*, to move)—means of movement or motion; projections or prolongations.

QUESTIONS.—What is a *capillary tube?* To what height does liquid rise in a tube? How may it rise higher? What is the difference in the surface of water and mercury in a tube, and what causes it? Explain fig. 2. What happens if we move the balls on? What difference does it make whether we dip one plate of glass or two into water? Explain figs. 3 and 4. How does a lump of sugar or a sponge prove capillary attraction? What is its effect in trees and in our bodies?

THE FLAME OF A CANDLE—PART II.—(PAGE 231).

Illustration (Latin, *in*, in; *lustro*, to shine)—explanation rendering clear what is obscure.

Patient (Latin, *patior*, suffer)—quietly persevering, calmly diligent.

Agitate (Latin, *agito*, stir)—disturb, or stir violently, shake or move briskly.

Links — torches made of tow, twisted lightly together and steeped in pitch (still used in London fogs).

Flambeaux—lights made of thick wicks (usually of coarse hemp yarn about three feet long) covered with wax; before the introduction of gas they were commonly used in the streets for lighting people to and from their houses, and at illuminations.

YOUNG CHEMIST—(PAGE 233).

Embers—cinders or smouldering remains of wood or coal, &c., when they have ceased to blaze.

Laboratory—a room constructed and fitted up for carrying on chemical experiments.

QUESTIONS.—What causes the dark spot in a flame of candle? Prove it is smoke? How can you make it burn and get two flames from the same candle? What does the experiment with the card show? How can a blown-out candle be lighted again by air? What does that show? Why do we use bellows to a fire? What raises the heat of a red ember till it blazes.

HEAT—(PAGE 235).

Infuses (Latin, *in*, into; *fundo*, to pour)—thrusts in, penetrates, instils.

Inseparable (Latin, *in*, not; *separo*, to separate) — not able to be separated.

Resistless energies—forces or activities that cannot be resisted.

Function (Latin, *fungor*, to perform a duty) — the duties or office of any part or organ of animal bodies.

Excess (Latin, *ex*, out; *cedo*, to pass)—that which goes beyond, or *surpasses* the average.

Deficiency (Latin, *deficio*, to fail)—falling short, imperfection, want.

Scientific phraseology — language or terms peculiar to any science.

Element — the first principle of anything, an ingredient, a constituent part of any composition.

Abstraction (Latin, *abs*, from; *traho*, to draw) — the drawing out, or withdrawal, by contact, of any element from a substance.

Unapproachable — not allowing

near contact, on account of some quality in it injurious to those who draw near to it.

Denominate (Latin, *nomen*, name)—call, give the name to.

Relative—that which has relation to something else.

Absolute—independent, belonging to itself alone.

Bulb (Latin, *bulbus*, a round root)—used of anything round at the foot of a stem, like an onion or turnip.

Sensible distance—at such a distance as to be felt.

Diffuse (Latin, *dis*, asunder; *fundo*, to pour out)—spread, extending in all directions.

Operating (Latin, *opera*, a work)—working or acting.

Transmitted (Latin, *trans*, across; *mitto*, to send)—sent from one person or thing to another.

Philosophically correct — exactly accurate, according to science.

Established—set up, or fixed.

QUESTIONS.—For what are we indebted to *heat?* What is meant by *caloric?* What is *cold?* What do we mean by temperature? When is it said to be *higher* or *lower?* What is *latent* heat? How is heat communicated? Distinguish between *radiation* and *conduction*. By which is the heat from a fire communicated to us? Explain why. What do we mean by *good conductors?* Name some of the best. Of what use is this knowledge of *conduction?*

MATTER—(PAGE 240).

Indestructible (Latin, *in*, not; *destruo*, destroy) — unable to be destroyed.

Perpetual motion — movement effected or supplied by itself without any impulse to cause it.

Inclined (Latin, *in*, into; *clino*, to bend)—bending towards an object, leaning, slanting.

Fulcrum (Latin, *fulcio*, to prop)—the prop or support upon which a lever rests.

Applications (Latin, *ad*, to; *plico*, to fold)—uses or means of employment.

Ultimate (Latin, *ultimus*, the last)—last, furthest, final.

Expenditure (Latin, *ex*, out; *pendo*, to weigh)—properly the weighing out of stores for use; so, the laying out or use of anything.

Contrivances — things invented or planned, instruments, appliances.

QUESTIONS.—What is *matter*, and what are *materials?* Name some. Why cannot we *make* matter or destroy it? Prove we cannot. What is force? Why cannot we either make or destroy it? Name contrivances for increasing force. Do they make or increase force? What is an inclined plane? a lever? If we can raise a heavier weight with them than without, how is it we have not made more force? Explain how heavier weights are raised by adding more pulleys. Show that they are all levers.

THE CENTRE OF GRAVITY—(PAGE 244).

Deviation (Latin, *de*, from; *via*, the way)—turning away from the straight line.

Suspending (Latin, *sub*, under; *pendeo*, to hang)—hanging anything downwards.

Stable (Latin, *sto*, stand)—fixed, settled, immovable.

Equilibrium (Latin, *equa*, equal; *libra*, a balance) — equally weighted or balanced. "*Stable equilibrium*" is the position (of a body resting upon another body) to which it naturally returns when slightly moved.

Homogeneous—of the same kind or nature; consisting of similar parts or elements.

Centre of magnitude—that point in a body which is equally distant from all the similar external parts of it.

QUESTIONS.—What is the *centre of gravity*, and what the *line of direction*? How does a person dance or walk on a tight rope? Explain fig. 1. Why does not the pail of water fall? Show why the cone (fig. 2) will roll up (fig. 3) from C to A B. Why does the cylinder in fig. 7 roll up the plane? How far will it roll? What is the principle of the clock (fig. 9)?

THE PHILOSOPHY OF A PEG-TOP—(PAGE 249).

Natural philosopher—one who studies the science of material natural bodies, their properties, powers, and motions.

Projectile force—a force driving a thing forward, or in a straight line.

Line of direction—the line in which a body moves, or in which a force acts, or in which motion is communicated.

Rotating motion (Latin, *rota*, a wheel)—circular motion round an axis, like that of a wheel.

In equilibrio—when two or more forces acting upon a body are so opposed to each other that the body remains at rest, although either would move it if acting alone, that body is said to be *in equilibrio.*

Retarding forces—forces which obstruct or lesson the velocity of motion.

Impediments (Latin, *impedio*, to hinder)—things which hinder or lessen force.

Disk (Latin, *discus*, a quoit)—any flat circular surface.

Plane (Latin, *planus*, flat)—an even or level surface, either real or imaginary.

Vacuum (Latin, *vacuus*, empty)—the inside of a close vessel, from which the air has been pumped out.

Lacquer—a varnish, consisting of shell-lac and alcohol, and usually coloured.

Appreciable—able to be felt.

Mathematical point—an imaginary point without any parts or size.

Tangent (Latin, *tango*, to touch)—a straight line which touches or meets a circle in one point without cutting through the curved line; the "direction of the tangent" would be in the straight line from the point at which it leaves the circle.

Parallel—a line which throughout its whole length is at an equal distance from another straight line; so it is used of lines extended in the same direction, and at all points equally distant.

Resolution of forces—the dividing of any single force into two or more others which, acting in different directions, shall produce the same effect as the given force.

Spherical—rounded, globular.

QUESTIONS.—What is a natural philosopher? What causes circular motion? Explain *centrifugal* and *centripetal* force. How do a sling and stone illustrate them? How might a top spin for ever? What was Mr. Serson's top? How long did it spin, and why so long? Why did lacquer spoil the spinning? Why does the top rise up straight, when does it *sleep*, why does it stop, and why fall to the ground?

THE PUMP—(PAGE 253).

Valves (Latin, *valvæ*, folding doors)—a kind of movable lid or cover, fitted into a vessel, and working on a hinge, to regulate the admission or escape of a fluid.

THE STEAM ENGINE—(PAGE 256).

Factory (Latin, *facio*, to make)—a place where anything is made, particularly by machinery.

Turning lathe—a machine with a rotating motion for turning and polishing various materials, giving them a circular shape.

Comrade piston—its companion piston, or the one on the opposite side.

QUESTIONS.—How is a squirt worked? Which is the piston? What makes the water rise in it, and why does it squirt out? Prove that water will rise in a vessel, if the air be taken out. What is a *vacuum?* How does a pump differ from a squirt? How does the water get up to the spout? What are valves, and what is their use? If a squirt was fitted on a tea-kettle, what would raise the piston? How can the piston be pushed down by steam? What contrivance puts the steam in alternately *above* and *below* the piston? What is the use of this? How does the piston work a wheel? How are *two* wheels worked?

INTERNATIONAL EXHIBITION—(PAGE 261).

Annexe (Latin, *ad*, to; *necto*, to twine or fix) — an additional building, distinct from, but adjoining the principal one.

Calico—cotton cloth, white and unprinted, so called from Calicut in India, where it was first made.

Palermo—a city and gulf at the north-western promontory of the coast of Sicily.

Algeria — the northern coast of Africa opposite to France, of which it is now a dependent state.

Trinidad—an island in the Gulf of Paria, north-east of S. America.

Abyssinia—east of Africa, south of the Red Sea, recently conquered by England to release some travellers unjustly imprisoned.

Engraving—the cuttingof pictures, writings, or other designs, on stones or metals, from which they can be printed.

Commercial botany—the study of plants, and a comparison of their respective excellencies, for the purpose of *commerce.*

Saturated flannel — flannel upon which as much liquid has been poured as it will contain.

Relief—a pattern raised above the surface.

Cameo — properly, stones cut *in relief*, the stone being composed of different coloured layers, so that the subjects, cut in relief, are of a different colour from that layer under them, which forms the base or back-ground; used for any imitation which gives a coloured figure on a ground of a different colour.

Fascinating—charming, pleasing, captivating.

Precision—accuracy, exactness.

Complex — composed of two or more parts; generally used of that which is compounded of a great many different parts, each capable of acting alone.

Hydraulic press—a machine contrived to compress substances or raise them, by means of the pressure which water exerts on the surface by which it is confined.

Solution—a mixture in which a solid has entirely disappeared in a liquid.

Electrotype—a plate taken from type set up ready for printing by a process recently discovered, by which perfect copies may be taken from medals, coins, or the raised surfaces on any metals; this is done by subjecting sulphate of copper to the action of a galvanic battery, by which the pure metal is laid in a film upon the surface, from which the copy is to be taken; this film can be separated from the surface, and will retain a faithful copy of the original.

QUESTIONS.—From what countries was cotton exhibited? How many varieties? What food is made from cotton? Give an account of a machine for making envelopes. What is the largest number made in a day? What is *graphotype?*

THE "WALTER" PRINTING PRESS—(PAGE 265).

Walter press—so called from the inventor, Mr. John Walter, M.P., proprietor of the *Times.*

Composing (Latin, *con,* together; *pono,* to place)—the art of setting types from a copy, arranging the letters in the proper order for printing.

Retention (Latin, *re,* again; *teneo,* to hold)—keeping in readiness.

Distributing—separating the types after printing with them, and placing them in their proper boxes in the cases.

Stereotype—the art of fixing types and transferring a cast of them to a metal plate.

Forme—a set of types composed and arranged in order, divided into pages or columns, inclosed and wedged in a chess ready to print from.

QUESTIONS.—How is type generally *composed* and *distributed?* Explain those two words. How does the "Walter Press" set up type? How much labour is saved by it? How do the letters get to their proper places? What is "justifying"? How is the type distributed? Why is it called the "Walter Press"?

H.M.S. "GLATTON"—(PAGE 266).

Ironclads—wooden vessels covered or *clothed* outside with thick solid plates of iron.

Monitors—ironclad gunboats very low in the water; so called from the first of the kind, made in America, to which this name was given.

Frigate—a ship of war, less than a ship of the line, having two decks, and carrying from 30 to 40 guns.

Bombardment—the act of throwing bomb-shells (round hollow shells of cast-iron filled with gunpowder) into a town or fort.

Acre—a fortified seaport of Palestine.

Training ship—a ship in which boys are trained to be sailors.

Yacht—light small vessels, used either for pleasure or for passage, and generally propelled by wind, but sometimes by steam.

Breakwater — a mound or wall, raised at the entrance of a harbour, to break the force of the waves and protect vessels at anchor.

Quarterdeck—that part of a deck of a ship between the stern and mainmast.

Signalling — the means by which vessels communicate one with another, usually by sails, flags, or guns.

The bolt—the cannon ball which had been shot.

Longitudinal (Latin, *longus,* long, —running lengthways.

Ubiquitous (Latin, *ubique,* everywhere)—appearing to be everywhere at the same time.

Protruded (Latin, *pro,* forward, *trudo,* to thrust)—thrust out, or projecting.

Teak—a very hard wood grown in the East Indies, used for ship timber, because so very hard, and not liable to splinter.

Phase—appearance, species, kind.

Flange—a projecting rim or rib on any substance, principally used of iron ribs.

QUESTIONS.—What has been the struggle between guns and vessels? Who first made the most formidable guns? What is meant by the "armour"? At what distance could the new gun scatter to pieces an armour of 5½ inches thickness? What is the thickness of armour on the "Glatton"? What weight of iron balls, and what force of powder will it resist? Describe the trial, and show how it proved successful. Why cannot a bigger gun be made to destroy the "Glatton"?

CHARCOAL—(PAGE 272).

Acetic acid—an acid, composed of carbon, hydrogen, oxygen, in the same uniform proportions.

Maceration—the process of softening, and almost dissolving a substance by steeping it in a fluid.

ILLUSTRATION OF LIGHT—(PAGE 274).

Optics—the science which treats of the nature and properties of light with respect to the eye, and the laws of vision, and instruments connected therewith.

Prism—a solid whose sides are cut into parallel edges, forming acute angles, and so splitting the rays of light.

Spectrum (Latin, *specio*, to behold) —the name given to an elongated image of the sun, formed on a wall or screen opposite to a hole in the window-shutter.

Membranes—very thin skins or films.

Impinges—falls against an object without piercing it.

Incidents (Latin, *in*, upon; *cado*, to fall)—the falling upon, or contact with.

Picturesque—pleasant to the sight, like a beautiful picture.

QUESTIONS.—What is charcoal, and how is it made? What gas is made by burning it? Why is it fatal to sleep in a room where charcoal is burnt? For what is charcoal used? How is light produced? Of what is a ray of light composed? How can it be split up? How is colour formed? How many colours are there in a ray of light? What is a *prismatic spectrum?* Describe the retina. Why, if we look at one colour for a time, and then remove it, do we see a form like it, *but of a different* colour?

ELECTRICITY—(PAGE 278).

Amber—a hard half-transparent substance, of a slightly yellow colour, tasteless, and without smell; believed to be a fossil resin; found in deposits in the mouths of rivers, or on the sea shore; and is used for making varnish.

Imponderable (Latin, *in*, not; *pondus*, weight)—incapable of being weighed.

Quiescent (Latin, *quies*, rest)—in a state of repose, still, not moving.

Identical (Latin, *idem*, the same)—similar; not different.

Apparatus (Latin, *ad*, to; *paratus*, prepared)—a set of instruments or tools for performing any operation or experiment.

Vitreous (Latin, *vitreus*, glass)—resembling glass, or of the same substance as glass.

QUESTIONS.—From what is the term *electricity* derived? What is it? How can you produce it? What is the difference in electricity produced by glass and sealing-wax? What are the two opposite states of electricity? Illustrate them by the sealing-wax, glass, and feather. What *law* is founded on these experiments? What things that we use commonly are very electric? What animal is so? What do we call such substances as allow electric fluid to pass through them readily? What are the opposite called?

THE ELECTRIC TELEGRAPH—(PAGE 282).

Telegraph—a machine for sending messages in an instant to a great distance.

Pivot—a pin or point on which anything turns.

Terminus (Latin, *terminus*, a boundary)—the extreme point at either end of a telegraph wire, to or from which messages are sent.

Zinc—a hard metal of a bluish white colour, excessively tough, very malleable and ductile; it is not found in the native state, but obtained from its ores; when heated strongly in air, it takes fire and burns with a beautiful bright light, known as the *electric light*.

QUESTIONS.—To what very useful purpose is electricity applied? What are telegrams? What is *galvanism*, and why so called? How is it produced? Of what must the plates be made? How far may they be apart? What is a "*battery*"? How are the batteries at London and Edinburgh joined? How is a message sent along the wire? What is the use of the *needle*, and how is it hung? How is it moved, and how does the clerk spell out letters with it? Which marks mean "to the right," and which to "the left"? Put down the proper marks for telegraphing "I have finished my exercise."

THE BODY AND ITS PARTS—(PAGE 289).

Enamel—a smooth, hard, shining substance placed as a glaze over a substance to give it a hard surface.

Marrow—an oily fluid, contained in the tubes and cells of bones.

Diagram—a figure or drawing for the purpose of explaining what is being taught.

Mastication—the act of chewing solid food and mixing it with saliva.

QUESTIONS.—How long *may* a man live? What parts of his body never stop all those years? Of what chief parts is the body composed? Describe the head and its parts, and the different kinds of teeth. Give the names of the bones of the arms and legs. Describe the principal kinds of joints. How is the body raised when you walk? How are the ankles and elbows bent? What are muscles? How do they act?

DIGESTION—(PAGE 297).

Gristle—a smooth, solid, elastic substance in animal bodies; bone without lime, therefore flexible.

Tripe—the large stomach of animals, prepared for food.

Thoracic-duct—a *conducting* pipe running up the back of the thorax, and conveying nourishment from the food into the veins.

Pylórus—a Greek word meaning a *gate-keeper*.

QUESTIONS.—How is the body restored as it wears out? What wears it away? Describe each stage in digestion. How is food *masticated*? What is meant by the word? What change is made in some food by mastication? How does food get from the mouth into the stomach? What is the nature of the stomach, and how does it act on the food? What liquid is mixed with it? Where does the food pass next, and what juices are mixed with it there? What change takes place in it? How is it drawn from the intestines, and carried to the blood? How is it turned into solid flesh and bone? When does this take place? Why cannot we do without sleep?

CIRCULATION—(PAGE 304).

Pulmonary—that which belongs to the lungs.

Auricle—a diminutive from the Latin, *aures*, the ear.

Ventricle—a diminutive from the Latin, *venter*, the belly.

Aörta—a rising main, from a Greek word meaning to *rise*.

Intestines (Latin, *intus*, within)—the minor tubes or pipes that convey the food from the stomach.

QUESTIONS.—What is the *centre* of circulation? How does blood get from an auricle into a ventricle? Why does it not run *back*? How is it conveyed to the lungs, and for what purpose? To which side of the heart does it go back from the lungs? What pipe carries it out into the body? Describe the complete course of circulation. What is represented in Fig. 18 by A, B, *b*, *c*, 1 and 4. In Fig. 17 what is the net-work above "Part of the intestines"? Define the various valves, and give their names. What are *pulmonary* veins, the *venæ cavæ*, hepatic artery?

RESPIRATION—(PAGE 312).

Clarionet—a wind instrument of music, like a small trumpet, made of wood, with a chisel-shaped mouth-piece containing a reed.

Flageolet—a small wind instrument of music like a flute with keys, but played by means of a flat mouth-piece at one end.

Residuary (Latin, *re*, back; *sedeo*, settle)—that which remains behind when part is taken away.

QUESTIONS.—Why does the blood require purification? What is its colour then? Where is it purified, and by what? How do the two gases change places? What is the colour of blood after purification, and what is it then called? What are the lungs like? How does blood come into contact with air? How are the lungs worked? How does air get into them? Why cannot we squeeze all air out? What is that called which remains? Why is it good to breathe air *out of doors*, and to take exercise?

BRAIN AND SENSES—(PAGE 318).

Medicine (Latin, *medior*, heal)—drugs taken for the purpose of healing diseases.

Olfactory (Latin, *oleo*, to smell; *facio*, to make)—exciting the sense of smell.

Concussion (Latin, *concutio*, to shake together)—the shock occasioned by two bodies coming suddenly into contact.

Vestibule (Latin, *vestio*, to clothe)—an ante-chamber where persons leave their hats and coats before entering the house; so, the ante-chamber, or entrance.

QUESTIONS.—What is the centre of sensation? What are the senses? Name them. What is the organ of taste, and what are the parts of it that feel *touch* and *taste*? What is the olfactory nerve and its use? How does it convey feeling to the brain? Describe the eye. Does it see, or only pass on objects of sight? What is the retina and its use, and what nerve is spread on it? How is sound produced, and carried to the ear, on what does it strike, and how is it passed on? What nerve carries it to the brain? How are sounds distinguished in *degree* and in *tone*?

WHOLESOME DRINK—(PAGE 326)

Quench—extinguish, put out a flame.

Mineral matter—matter containing mineral substances derived from the earth, and conveyed chiefly to the human body through vegetables.

Fermented (Latin, *ferveo*, to boil)—having become heated, or boiled from internal decomposition.

Perspiration (Latin, *per*, through; *spiro*, breathe)—a vapour breathed out of the body through the pores of the skin.

Avocation (Latin, *voco*, to call)—calling, or employment.

Mathematical certainty—with a certainty, that it cannot be anything else, like the right answer to a sum in arithmetic.

Physician—a person highly skilled in the treatment of diseases, who gives advice and prescribes remedies in extreme cases only.

Fetid (Latin, *fœteo*, to have an ill smell)—smelling offensively, filthy.

Plied—supplied continually.

Sub-acute—acute or severe, in a moderate degree.

Nervous excitement—an excessive or unhealthy excitement of the nerves.

QUESTIONS.—What are the proportions of liquid and solid matter in the body? What liquid does it want, and for what purpose? Why is alcohol bad for it? What liquids are best to work upon, and why? Why is water the most wholesome drink? What is the effect of fermentation? How much *nourishment* is there in the best beer? How is alcohol bad in sickness? When may it be used, and how? Which is the most successful treatment in fevers?

WORD LESSONS.

PAGE 213.

Paradoxical—puzzling, contradictory.

PAGE 216.

Effectual—successful, efficient, adequate.

Vitiate—spoil, befoul, poison.

PAGE 233.

Deficiency—failing, want, imperfection, loss.

Abstraction—withdrawal, separation, disconnection.

PAGE 240.

Indestructible—permanent, eternal, immortal.

Inclined—slanting, sloping, leaning.

Contrivances—devices, appliances, instruments, means.

PAGE 278.

Identical—twin, counterpart.

Quiescent—still, reposing, quiet, immovable.

Vitreous—glassy, transparent, crystalline.

PAGE 304.

Residuary—remaining, stationary, permanent.

PAGE 318.

Concussion—shock, collision, contact.

Avocation—calling, business, profession, employment.

HÆMORRHAGE—(PAGE 339).

Tissues—the peculiar structures of any part of the body, especially the simple elements diffused through it.

Corpuscles (a diminutive from the Latin, *corpus*, a body)—a name given to the small grains floating in the blood.

Counter-pressure—a pressure against that which is being used.

POISONOUS GAS IN WELLS—(PAGE 342).

Emergency—a pressing necessity, anything requiring immediate action.

Suspended animation — stoppage of the pulse, breath, or consciousness, as in fainting or drowning.

QUESTIONS.—What causes death from loss of blood? How can you tell whether an artery or vein is bleeding? How would you stop it in each case? How can you tell when there is bad gas in a well? What should be done to get it out? Why should no one go down till it is got out?

RESTORING THOSE APPARENTLY DROWNED—(PAGE 345).

QUESTIONS.—What is the *first* thing to be done? What can others be doing at the same time? What do you want to restore first? How is breathing to be *restored?* How *excited?* How *imitated?* What else is to be done *at the same time?* Give another way of imitating breathing. When it is restored, what is the next step? How do you commence *promotion* of warmth? Why is plenty of *air* necessary? What liquids may be given, and when? What is the next thing to be promoted? How long should you persevere? How can you tell when the person is *dead?* Write out the "Cautions."

FIRE—(PAGE 350).

What should people ascertain *before* any fire happens? What is to be their *first* thought when fire breaks out? How should they clothe themselves? Why shut the doors? What part of a burning house is most free from smoke? Why? What will help you to breathe in smoke? To what window should you go? How can you let yourself down? Why not throw yourself out of the window? How can a fire be kept down? What ought by-standers to do? What should they *not* do? How are you to act if your clothes catch fire? What should you do if the clothes of some one else were on fire?

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